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UNITED STATES
DEPARTMENT OF AGRICULTURE
CIRCULAR No. 206

Washington, D. C. February, 1932

AGRICULTURAL INVESTIGATIONS AT THE UNITED STATES FIELD STATION, SACATON, ARIZ.
1925–1930

By

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Bureau of Plant Industry

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CONTENTS

Introduction 1
Climatic conditions 3
Agriculture on the Gila River Indian Reservation 8
Cotton in the Salt River Valley 10
Cotton-disease investigations 13
Cotton cultural experiments 24
Physiological studies of cotton 40
Cotton of the Egyptian type 41
Other field crops 46
Orchard crops 51
Truck crops 59
Reference herbarium 62
Literature cited 63

INTRODUCTION

This report presents the results and progress of experiments at the United States field station at Sacaton, Ariz., from 1925 to 1930, and includes brief statements of cotton conditions in the Salt River Valley and of new irrigation and agricultural developments on the Gila River Indian Reservation.

The station is conducted on the basis of cooperation between the Bureau of Indian Affairs, United States Department of the Interior, and the Bureau of Plant Industry of the United States Department of Agriculture. Investigations are carried on with many crops and plants that show adaptation to the Southwestern States, special attention being given to those having possibilities which might be of value to the Pima Indians. A seed farm is maintained for increasing the stock of pure seed of new or improved strains that are developed at the field station for distribution to the Indians of the reservation. (Fig. 1.)

The investigations are also the result of cooperative arrangements between several divisions of the Bureau of Plant Industry, especially the Divisions of Cotton, Rubber, and Other Tropical Plants; Egyptian Cotton Breeding; Genetics and Biophysics; Horticultural Crops and Diseases; and Cereal Crops and Diseases. The investigations during the period of this report included the breeding and selection of cotton, cereals, and sorghums; variety tests; spacing tests; irrigation experiments; cultural methods; rotation studies with various field crops; studies of dates, pecans, and citrus varieties; pollination of dates; and adaptation of foreign plants. Special attention is given to the life history and habits of the cotton root-rot fungus and methods of controlling the disease. Other cotton diseases are studied to some extent, especially crazy top, root knot, and sore shin. Experiments on cotton ginning and an investigation of the effects of weathering on seed cotton are carried on in cooperation with the Bureau of Agricultural Economics. The station has also cooperated with other agencies in maintaining stocks of pure seed of the Pima and Acala varieties for planting in the Salt River and Gila River Valleys. All of these activities are expected to be beneficial to the Pima Indians, as well as to the white growers of cotton and other crops, the prosperity of the Indian agriculture being closely dependent upon that of the general agriculture of the region.

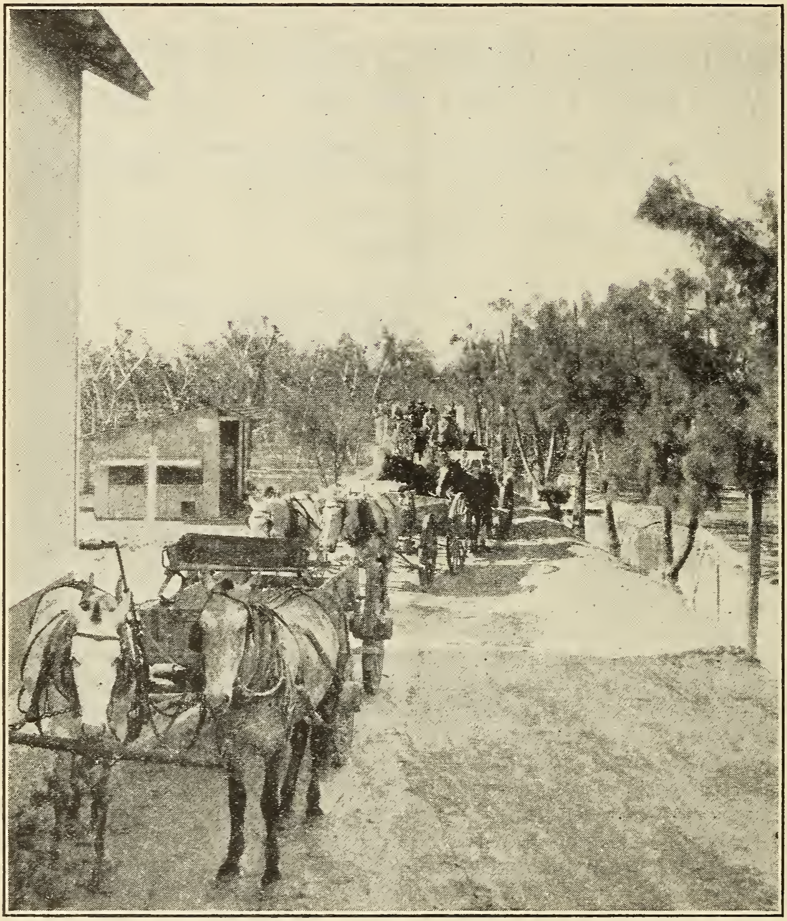

FIGURE 1.—Pima Indians waiting their turn at the agency warehouse to receive Pima cottonseed for planting. The stock of pure seed of the Pima variety is increased at the seed farm each year for distribution to the Indian farmers

A diagram showing the location of buildings and the arrangement of crop experiments at the field station in 1929 is shown in Figure 2.

CLIMATIC CONDITIONS

Climatic conditions in the middle Gila and Salt River Valleys are characterized by mild sunny winters, long hot summers, and warm dry springs and autumns.

The annual rainfall at Sacaton averages slightly less than 10 inches. The period of heaviest rainfall is during July and August, and another period of moderate rainfall occurs during December and January. The driest period is during April, May, and June. A special feature of the climate is the low atmospheric humidity, which makes the high daytime temperature endurable without great discomfort and causes rapid cooling at night. Another characteristic feature of the climate is the wide range in temperature between day and night. The mean daily range at Sacaton is about 35° F.

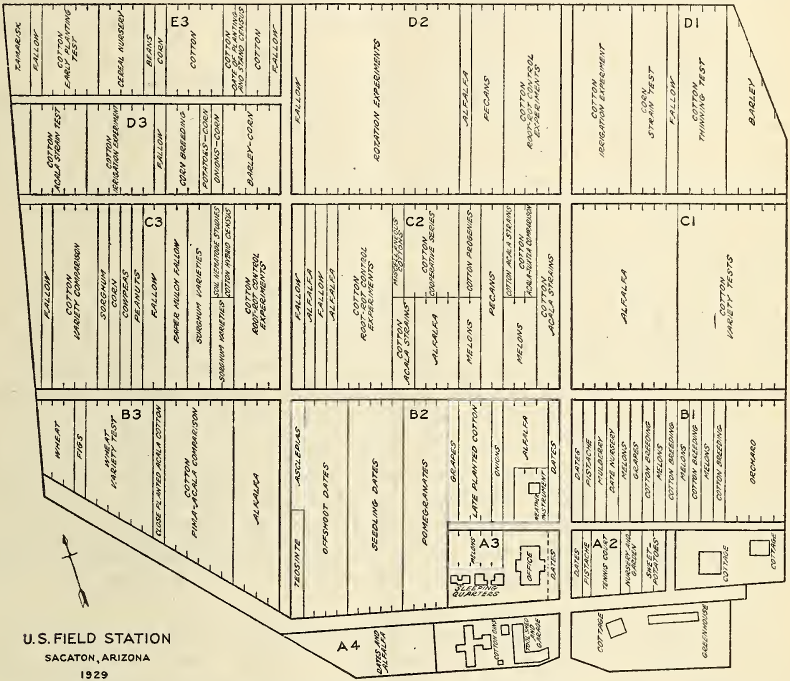

FIGURE 2.—Diagram of the United States field Station, Sacaton, Ariz., showing arrangement of field and location of experiments in 1929

The mean length of season free from killing frosts is about 263 days, which makes it possible to grow to maturity crops of a subtropical nature, such as Egyptian cotton, dates, olives, and pomegranates.

Some noteworthy features of the weather conditions in 1925 were the unusually early spring, with abnormally warm weather in February and March, an exceptional heat wave in July, and excessive rains in August. June was unusually cool, but the cotton crop was well advanced, being affected by the warm weather of August, and the final yields were satisfactory.

In 1926 there was excessive precipitation, especially in April, July, and September. The rainfall for the season was 6.21 inches above the average for 21 years. The mean temperatures during March, April, and June were unusually high. Much cotton had to be replanted on account of the rains in April, but by the last of June the crop was as well advanced as normally. The heavy rainfall in late summer caused rapid growth of the plants with excessive shedding at times, especially on upland cotton. Yields for the year were somewhat below the average for upland varieties, but were about normal for Pima.

The year 1927 was characterized by very pleasant weather from a physical viewpoint, the winter being unusually warm and the summer cool, with an exceptional amount of rain during June. The season was not especially favorable, however, for crop production. Late frosts about mid-April were damaging to fruit and to the cotton crop. Cool weather in June also retarded the cotton, but shedding was unusually light during the entire season. Warm weather in October favored cotton, and a heavy top crop was set.

The year 1928 was warm and exceedingly dry. The dry warm spring permitted the early planting of cotton, and the early development was about normal. Dry weather continued through September and October, and cotton matured earlier than normally and was harvested rapidly where adequate labor was available. As a whole, 1928 was an exceptionally good cotton year, and the mean yields were unusually high.

The year 1929 was exceptionally cool and dry. Cold weather in March and April, together with the precipitation in April, which was about normal, interfered to some extent with the development of early planted cotton, and poor stands necessitated considerable replanting. June was dry with warm days and cool nights. On June 24 a temperature of 113° F., the highest of the year, was recorded at Sacaton, and many records for high temperatures were broken in other sections of Arizona. July and August were warm and rainy, resulting in excessive shedding of cotton. Rains in September interfered with cotton harvesting, and the bollworm or corn earworm (*Heliothis obsoleta* Fab.) did much damage to the late crop of bolls. Yields for 1929 were lower than average for both upland and Pima cotton.

In 1930 the precipitation was abnormally high and the temperatures unusually low. Rainfall in January, March, July, August, and November was much higher than the 21-year average for these months. The total for the year was higher than for any year since 1919. The large amount of flood water resulting from the summer rains was especially useful to the Salt River and San Carlos irrigation projects on account of the small quantity of stored water available. The high minimum temperatures at planting time in April, the low minimum in May, and low maximum during July, August, and September were favorable for the cotton crop. On the best lands the yields were higher than usual. Unusually low temperatures from December 18 to 24 resulted in considerable damage to plantings of young citrus trees in parts of the Salt River Valley. A minimum of 20° F. at the field station, and 23° at the seed farm were recorded on December 21.

A small difference in the elevation, topography, and air drainage between the field station and the seed farm is responsible for a considerable difference in the general character of the climate, especially the humidity, rainfall, and minimum temperatures. The field station is located in a low area near the Gila River, where the land is level and there is little opportunity for rapid air drainage. The seed farm is situated on sloping land about 40 feet higher than the field station and about 1 mile south of it. This difference in temperatures and air conditions at the seed farm makes it possible successfully to grow citrus and many of the less hardy plants that can not be produced at the field station. Date palms also react favorably to the higher temperatures at the seed farm, the trees showing less injury from cold and the fruit less damage from moisture.

The meteorological records for the years 1925 to 1930, the average of the data obtained for the 21 years from 1910 to 1930, and the absolute maximum and minimum temperatures at the seed farm from 1918 to 1930 are summarized in Table 1.

Table 1.—*Summary of meteorological records at the United States field station, Sacaton, Ariz., showing the 21-year mean from 1910 to 1930, compared with each year from 1925 to 1930, and including absolute maximum and minimum temperatures at the seed farm from 1918 to 1930*

MEAN TEMPERATURE (° F.)

Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
21-year mean	50.1	54.3	59.6	65.7	73.6	83.1	87.9	86.7	81.2	69.1	58.1	50.1
1925	48.2	56.6	59.0	67.1	76.6	80.0	89.0	85.5	78.0	67.4	55.8	50.7
1926	47.4	56.7	63.6	67.9	73.3	84.4	89.3	85.7	81.8	71.5	59.2	50.7
1927	53.9	57.2	57.8	65.7	74.0	79.5	88.8	88.6	80.3	69.2	62.6	48.1
1928	49.3	51.8	61.9	65.0	76.6	82.7	88.5	85.4	82.3	69.6	57.8	48.4
1929	46.8	50.2	57.1	63.7	74.6	82.4	87.9	86.3	80.5	70.0	54.2	52.4
1930	50.0	55.1	58.7	69.4	68.5	83.4	87.7	84.1	79.0	67.0	58.3	49.2

MEAN MAXIMUM TEMPERATURE (° F.)

Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
21-year mean	66.0	70.6	76.3	83.2	92.4	102.0	102.1	100.6	97.3	86.9	75.9	66.1
1925	65.9	74.8	80.0	85.4	94.2	94.8	103.0	98.2	93.9	81.4	73.3	66.4
1926	63.4	74.1	79.8	81.3	90.6	103.6	102.5	100.7	96.2	87.6	77.1	63.8
1927	70.0	70.5	73.8	82.6	93.2	98.6	103.5	99.1	94.5	87.3	81.9	63.2
1928	68.2	68.0	79.1	83.7	93.7	101.4	103.9	99.3	98.3	86.2	73.8	65.3
1929	63.2	65.5	74.1	81.1	93.6	102.6	100.4	99.8	94.4	87.8	73.8	72.8
1930	63.0	72.0	75.9	86.9	87.0	101.9	101.0	96.7	96.1	86.2	73.3	66.0

MEAN MINIMUM TEMPERATURE (° F.)

Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
21-year mean	34.0	37.8	42.1	48.2	54.9	64.3	73.4	71.8	65.0	51.2	40.2	34.1
1925	27.6	38.4	43.0	48.7	59.0	65.2	75.0	72.9	62.1	53.4	38.2	35.0
1926	31.4	39.2	47.3	54.4	55.9	65.1	72.2	70.7	67.4	55.5	41.4	37.7
1927	37.9	43.9	41.9	48.9	54.9	63.7	75.1	72.0	66.2	51.1	43.2	33.1
1928	30.5	35.7	44.6	46.3	59.3	64.1	73.2	71.4	66.4	52.9	41.8	31.5
1929	30.3	35.0	40.1	46.3	55.6	62.7	75.5	72.8	66.7	53.6	34.6	31.9
1930	37.0	38.2	41.5	51.8	50.0	64.9	74.4	71.4	61.9	47.8	43.2	32.4

ABSOLUTE MAXIMUM AND MINIMUM TEMPERATURES (° F.)

Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Absolute maximum:												
1910	81	84	98	106	117	114	115	110	111	107	92	82
1911	81	80	92	95	101	109	109	109	108	96	88	86
1912	84	84	84	92	107	112	110	113	104	96	90	73
1913	73	80	90	98	103	108	112	110	108	100	89	76
1914	79	88	96	100	109	114	113	114	108	96	95	75
1915	75	80	88	97	107	111	113	113	108	105	98	79
1916	75	86	98	101	105	114	113	110	108	92	94	88
1917	79	79	90	93	102	112	111	103	104	102	90	80
1918	82	80	84	92	96	111	106	111	104	99	91	78
1919	74	77	84	97	98	110	106	109	103	89	83	75
1920	81	75	82	92	101	108	111	105	103	99	82	78
1921	80	92.5	93	97.5	101	110	107	106	103	99	88	79

TABLE 1.—*Summary of meteorological records at the United States field station, Sacaton, Ariz., showing the 21-year mean from 1910 to 1930, compared with each year from 1925 to 1930, and including absolute maximum and minimum temperatures at the seed farm from 1918 to 1930*—Continued

ABSOLUTE MAXIMUM AND MINIMUM TEMPERATURES (° F.)—Continued

Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Absolute maximum—Continued.												
1922	72	82	86	93	107	114	111	109	107	100	81	74
1923	83	82	85	92	105	112	111	105	106	96	79	74
1924	72	80	85	91	102	109	108	109	107	98	94	80
1925	79	83	91	99	104	108	113	106	101	96	84	78
1926	74	93	87	96	102	112	109	105	103	94	82	81
1927	81	82	87	98	106	111	111	110	104	97	87	76
1928	77	81	90	97	103	110	112	107	106	99	86	82
1929	72	81	87	90	101	113	108	105	103	100	84	79
1930	77	86	84	98	101	109	109	108	105	94	88	75
Absolute minimum:												
1910	17	17	32	39	44	56	62	65	55	40	33	24
1911	18	24	37	35	43	52	57	61	54	36	19	17
1912	17	25	35	36	42	54	56	65	49	33	31	20
1913	9	29	27	36	39	48	61	61	43	37	38	28
1914	25	27	33	42	44	56	68	67	60	47	35	21
1915	23	30	30	41	33	51	58	65	48	43	22	24
1916	27	24	33	35	44	54	62	63	55	37	21	15
1917	28	27	25	35	42	44	69	59	48	33	31	23
1918	20	27	34	38	46	52	66	58	53	30	25	26
1919	20	28	28	40	52	45	69	62	56	36	27	29
1920	27	33	31	37	43	53	58	58	48	35	20	21
1921	20	24. 5	30	31	42	48	58	68	55	30	21	22
1922	17	24	22	30	38	49	68	68	59	32	26	28
1923	20	24	26	35	43	48	67	65	44	36	30	25
1924	24	23	31	31	52	53	57	57	49	33	22	21
1925	15. 5	29	29	35	47	49	62	66	52	47	27	24
1926	22	29	34	46	46	57	59	64	57	44	29	23
1927	26	32	32	38	42	51	60	65	52	42	30	25
1928	21	28	31	29	52	51	62	61	54	37	23	18
1929	20	20	26	31	42	50	69	67	59	32	26	21
1930	26	30	26	42	39	49	68	64	52	37	24	20

ABSOLUTE MAXIMUM AND MINIMUM TEMPERATURES (° F.) AT SEED FARM

Absolute maximum:												
1918	------	------	88	93	97	113	108	112. 5	104	99	90	79
1919	72. 5	75	86. 5	98	99	112	107	106. 5	104. 5	90. 5	83	74
1920	78	77	82	93	103	111	114	106	103	98	81	71. 5
1921	76. 5	91. 5	93	98	101. 5	111	108	103	103	99	89	77
1922	71. 5	80	85	93	107	113	110	108	104	99	81. 5	74
1923	84	83	84	93	104	112	111	104	102. 5	94. 5	79	73
1924	71. 5	81	83. 5	91	102	110. 5	108	108	106	96	91	77
1925	76	81. 5	89	97	103	105	106. 5	104	100	94	82	75
1926	74	85	84. 5	94	100	109	110	105	102	95	81	78
1927	78	82	86	99	103	104	112	112	103	95	84	79
1928	76	80	89	98	104. 5	111. 5	111	107	101	97	85	81. 5
1929	73	81	87	91	101	113. 5	109	104	101. 5	98	82	78
1930	75	86	85	101	102	109	110	108	105	94	87	74
Absolute minimum:												
1918	------	------	35	39	48	57	61	61	56	40	26	28
1919	21	29. 5	30	40	53	51. 5	68	67	57	37. 5	27	32
1920	30. 5	35. 5	33	37	44	57	62. 5	60	51	36. 5	31	21
1921	22. 5	26. 5	35. 5	36	42	51	64	66	56. 5	38. 5	22	30
1922	18	25	26	32	42	51	70	67	59	35	28. 5	28. 5
1923	23	26. 5	30	39	47. 5	51. 5	66. 5	68	46	36. 5	33	27
1924	26. 5	28	33	34	53	58	63	60	54	36	31. 5	26
1925	21. 5	36. 5	36. 5	37	53	54	64. 5	67	54	47	32	28. 5
1926	24	33	35	46	48	60	64	62	59	46. 5	34	21
1927	29. 5	34	34	39	43	52	61	67	55	46	37	26
1928	23	30	34	33	53	54	65	65	56	39	26	23
1929	22	27	30. 5	36	47. 5	53	68	65. 5	60	34	24	25
1930	28	32	33. 5	42. 5	41	54	68. 5	67	53. 5	41	28	23

TABLE 1.—*Summary of meteorological records at the United States field station, Sacaton, Ariz., showing the 21-year mean from 1910 to 1930, compared with each year from 1925 to 1930, and including absolute maximum and minimum temperatures at the seed farm from 1918 to 1930*—Continued

RAINFALL (INCHES) [1]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1910	0.75	------	0.50	------	------	------	0.65	1.45	------	------	2.36	0.31	6.02
1911	1.52	0.69	.47	------	------	------	.11	.82	1.38	1.40	------	.25	6.64
1912	------	------	2.61	0.85	0.38	0.98	4.27	1.02	------	.96	------	1.05	12.12
1913	.72	.72	------	.40	------	.07	.92	.73	.04	.18	2.63	.81	7.22
1914	.18	.39	1.02	.16	.10	.34	3.26	1.77	.30	2.28	1.79	5.16	16.75
1915	2.45	1.45	1.01	1.16	.69	.10	2.44	1.05	------	------	.44	3.85	14.64
1916	2.87	.26	.71	.45	------	------	1.19	.63	3.61	.02	------	.65	10.39
1917	1.47	.67	.40	.11	1.29	------	3.33	.05	.43	.16	------	------	7.91
1918	1.15	.77	1.17	.19	------	.20	1.09	1.63	.47	.29	.88	2.07	9.91
1919	.01	1.47	.55	.20	.04	------	3.76	1.63	1.80	.15	2.48	.89	12.98
1920	2.03	.98	1.41	.03	.17	.23	.48	.89	.21	1.21	------	------	7.64
1921	.44	.34	.09	.08	.09	------	2.41	3.26	.39	.23	.11	.80	8.24
1922	1.11	.41	1.23	.78	.22	.11	.53	3.32	.55	------	1.20	.26	9.72
1923	.67	.64	.81	.16	------	------	3.27	.97	.01	.24	2.36	3.25	12.38
1924	------	T.	1.33	.25	.51	------	.39	.20	.40	.49	T.	1.86	5.43
1925	.11	T.	.18	.62	.14	.14	.54	3.09	1.78	.85	.19	.93	8.57
1926	.99	.35	3.40	1.16	.46	T.	2.54	.94	3.36	.60	------	2.12	15.92
1927	.14	1.51	1.11	.54	------	.52	.05	.42	2.26	.15	.02	.64	7.36
1928	------	1.37	.13	.01	.04	------	.78	1.99	.23	.32	.11	.61	5.59
1929	.64	.37	------	.26	.36	------	1.22	1.66	1.44	------	------	------	5.95
1930	2.27	.12	2.19	.25	.66	T.	1.79	3.12	.14	.10	1.92	.01	12.57
21-year mean	.93	.60	.97	.36	.25	.13	1.66	1.46	.90	.46	.80	1.22	9.71

EVAPORATION (INCHES)

Mean [2]	2.253	2.844	4.395	5.742	7.936	8.759	8.151	7.162	6.107	4.313	2.885	2.074	61.880
1925	2.206	3.352	5.019	6.944	8.887	8.481	9.705	6.785	6.294	3.400	2.673	2.478	66.224
1926	1.900	2.904	3.729	3.542	7.489	8.866	7.897	7.441	4.938	4.175	2.762	1.386	57.029
1927	2.112	1.887	4.463	5.250	7.838	7.004	7.728	6.225	5.688	4.651	2.629	2.009	57.484
1928	2.124	2.725	4.729	6.324	7.643	9.191	8.346	6.864	5.970	4.153	2.877	2.068	63.014
1929	3.404	2.734	4.585	------	------	9.979	8.379	7.376	5.837	4.275	2.576	2.065	------
1930	1.930	------	3.907	5.632	7.288	9.426	8.928	9.145	6.400	4.861	4.207	2.201	------

MEAN DAILY WIND VELOCITY (MILES PER HOUR)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum:												
1925	3.3	5.9	5.1	6.4	3.6	3.9	3.5	3.0	2.9	2.0	2.6	4.1
1926	5.0	3.3	4.0	3.7	3.9	2.5	3.0	2.2	2.3	2.2	2.7	3.2
1927	4.0	2.9	4.7	4.2	4.4	2.7	2.6	3.0	2.5	2.2	1.7	4.2
1928	2.3	2.9	5.2	5.4	4.8	4.8	2.5	2.0	3.4	3.2	3.3	2.0
1929	2.9	6.6	6.7	3.9	5.8	3.4	2.9	2.2	2.1	2.7	2.7	2.5
1930	2.9	------	3.4	3.7	5.7	3.4	2.2	1.8	2.6	2.8	4.2	3.8
Minimum:												
1925	1.2	.5	.13	1.4	1.0	1.5	.2	.6	.1	.2	.2	.4
1926	.6	.9	.7	.7	.7	.9	.9	.6	.3	.4	.4	.5
1927	.7	.9	1.6	.6	1.1	.8	.7	.8	.7	.7	.4	.6
1928	.9	.8	.9	1.2	1.2	1.1	.9	.0	.2	.4	.7	.7
1929	.0	1.1	.7	1.3	.9	1.2	.5	.7	.8	.7	.8	.4
1930	.6	------	.9	.7	.8	.9	.5	.5	.6	.8	.6	.8
Mean:												
1925	1.7	2.2	2.4	2.6	2.1	2.5	1.8	1.4	.9	.8	1.3	1.7
1926	1.5	1.9	2.1	2.1	1.8	1.6	1.6	1.4	1.2	1.0	1.1	1.2
1927	1.4	1.6	2.4	2.0	2.1	1.6	1.5	1.5	1.3	1.2	1.0	1.6
1928	1.4	1.5	2.1	2.2	2.0	2.2	1.5	1.1	1.1	1.1	1.4	1.1
1929	1.2	2.1	2.2	2.1	2.1	1.9	1.6	1.4	1.3	1.2	1.3	1.2
1930	1.4	------	1.9	1.7	2.0	1.6	1.3	1.0	1.2	1.2	1.5	1.3
13-year mean	1.7	2.0	2.2	2.3	2.1	1.8	1.6	1.3	1.4	1.2	1.4	1.5

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[1] T.=trace.

[2] Means are from complete records for following numbers of years: August, September, October, November, and December, 14; January, March, June, and July, 13; February and April, 12, May, 11.

AGRICULTURE ON THE GILA RIVER INDIAN RESERVATION

The 6-year period since the last station report (*8*)[1] has witnessed a decided change in the agricultural status of the Pima Indians on the Gila River Reservation. The Coolidge Dam, which was authorized by act of Congress in 1924, was completed in the spring of 1929 and is now being utilized for storing water for the lands of Pima Indians and for a large area of land owned by white settlers on the San Carlos project. (Fig. 3.)

Ample water is now available for all of the Indian lands that have been cleared on the eastern portion of the reservation. Extensive clearing and leveling operations under the direction of the superintendent of the reservation have been in progress since the spring of 1929. A large part of this newly cleared land of the Indians has been planted to wheat and cotton, and smaller areas to alfalfa, beans, corn, and grain sorghums. The yields for the most part have been satisfactory. (Fig. 4.) One Indian farmer in 1930 produced more than a bale of cotton per acre on 60 acres of new land. The average, however, was much smaller. In 1930, the average yield per acre of some of the crops grown on the reservation by the Indians was as follows: Wheat, 22 bushels; hegari, 20 bushels; cotton, one-half bale; tepary beans, 300 pounds; pink beans, 500 pounds.

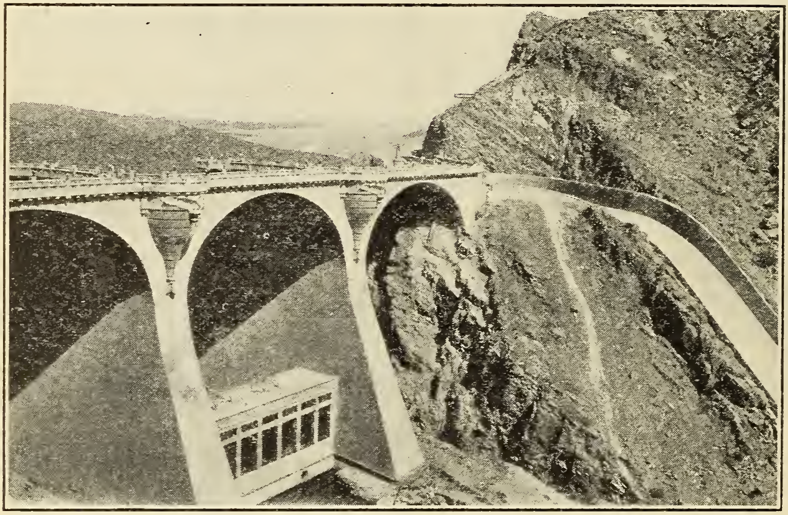

FIGURE 3.—The new Coolidge Dam, which impounds water for the San Carlos project, including the Gila River Indian Reservation. View of the downstream face, showing the multiple-dome type of construction, the power house, one of the spillways, and the partially filled lake beyond

A census of the Indian farms and of the acreage in various crops during 1929 showed that, of 29,530 acres of available farm land, crops were harvested from only 7,774 acres, owing to lack of irrigation water. There were about 2,100 acres in wheat, 3,000 acres in cotton, and 1,600 acres in alfalfa. The yields obtained were 29,913 bushels of wheat,

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[1] Italic numbers in parentheses refer to Literature Cited, p. 63.

1,264 bales of cotton, and 4,790 tons of alfalfa. The total estimated value of all Indian farm crops in 1929 was $354,703.

With the prospect of a much larger farming area on the reservation, and with ample water now available for many kinds of crops, the experiment station is making an effort to interest the Indians in a number of new crops that seem well adapted to their conditions and use. The date palm especially should be of much value to them, as it yields a highly nutritious food product and requires only moderate care once the trees are established. A considerable number of young rooted palms have been distributed among the Indians during the last two years to demonstrate their possibilities.

Other plants that are propagated in nurseries and distributed to the Indians each year are grapes, figs, and pomegranates. (Fig. 5.) The planting of a few pecan trees on some of the allotments that have especially deep soil near the river is being advised. Efforts also are being made to promote the culture of special crops such as sweet-potatoes, pink beans, tepary beans, and winter vegetables, and to increase the planting of alfalfa. For some of the higher, frost-protected lands it is planned to try citrus trees for dooryard plantings.

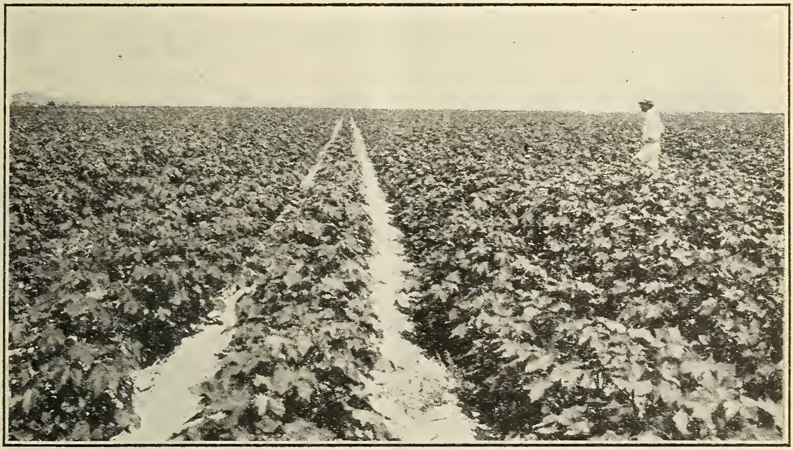

FIGURE 4.—Field of upland cotton grown by a Pima Indian farmer on land that was cleared of native vegetation a few months previously. About 50,000 acres of Indian land on the Gila River Reservation will be cleared and leveled to receive irrigation water from the Coolidge Reservoir

Plans of the Bureau of Indian Affairs call for the clearing and leveling of 50,000 acres of land to be irrigated from the stored waters behind the Coolidge Dam. It is difficult for some of the Indians to realize that they are at last to have an adequate and continuous supply of water for their lands. A. H. Kneale, superintendent of the Gila River Reservation, comments as follows on the discouraging conditions under which they have existed:

> For decades practically the only water they could secure access to was flood water. Only when the Gila was in flood could the Pimas irrigate their fields. No farmer can operate successfully when limited solely to intermittent flood waters. The wheat fields of the Pimas ceased to produce and gradually many of them reverted to type—mesquite and sage brush again came into their own.
>
> Some of the Pimas continued to do their part. Sedulously did they continue from year to year to prepare their fields and seed them. It is not necessary to

portray the result. The only thing about it worthy of comment is that, undismayed by repeated crop failures, some of the Pimas never failed to do their part.

Referring to the effects that the completion of the Coolidge Dam will have on the Pima Indians, Mr. Kneale says:

> The last year has seen as great a change in the mental aspect of the Pima Indians as the next 10 years is going to show in physical aspect of the acres that now comprise the San Carlos Project. No one so greatly appreciates a thing as the person who, once possessing it, has later been deprived of it. There are none so keenly appreciative of the Coolidge Dam and all that it represents as are the Pima Indians. Five hundred and seventy acres of winter wheat were planted in the fall and winter of 1929–30, and also considerable acreages of barley and a small acreage of alfalfa, all of which produced exceptionally well. Six hundred and fifty acres of cotton and a considerable acreage of grain sorghums and corn was planted on the new lands in the spring and summer of 1930, and 1,500 acres of wheat in the fall of 1930.
>
> The Indian Office has aggressively attacked the problem of subjugating such allotments as remain in a virgin state, and it is hoped and believed that the next few years will see the Pima Indians in possession of 50,000 acres of fertile soil all well watered from a dependable supply and all in a state of cultivation.

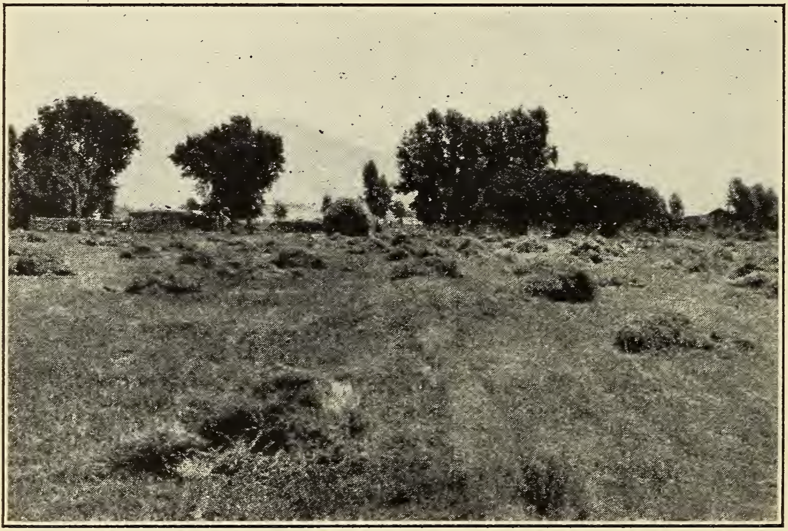

FIGURE 5.—Home and surroundings of a progressive Indian farmer. The original adobe home is at the left and the frame house, a new improved home, at the right. On the premises are to be found figs, peaches, apricots, pomegranates, dates, and grapes. For shade trees cottonwoods and athels have been planted

COTTON IN THE SALT RIVER VALLEY

A noteworthy feature of cotton production in the Salt River Valley during the last few years was the marked fluctuations in the acreage planted to Pima (American Egyptian) and upland cotton as a result of the growers' shifting from one type to the other in an attempt to follow price changes. The very low price differential between the two kinds of cotton in 1924 resulted in the planting of 122,000 acres of upland cotton in 1924 and only 8,000 acres of Pima. The relatively low price for the upland crop of 1924, due to the overproduction in the world's supply of the shorter stapled cottons, threw the advantages to production of Pima, and since that time greater average returns per acre have been realized from Pima, as shown by an economic survey made by the Bureau of Agricultural Economics and the Extension Service of the United States Department of Agriculture, and the agricultural experiment station of the University of Arizona (*17*). The December price of Pima cotton during the years 1924 to 1930 fluctuated between 19 and 47 cents, while the upland price ranged from 9.8 to 23 cents. The Pima acreage was increased from 8,000 acres in 1924 to 62,400 in 1929. Meanwhile the upland acreage fluctuated considerably, being as high as 122,000 acres in 1924 and as low as 39,185 in 1927.

In Table 2 are given some comparative data on the acreage, production, and price of Pima and upland cotton in Maricopa County, as obtained from the economic survey and other sources for the years 1924 to 1930.

TABLE 2.—*Acreage, total production, acre yield, price, and acre value of Pima (American Egyptian) and upland cotton, 1924–1930, in Maricopa County, Ariz.*[1]

PIMA (AMERICAN EGYPTIAN)

Year	Acreage	Total production	Acre yield of lint	Price f. o. b. Phoenix, Dec. 1	Gross value per acre
		Bales	*Pounds*	*Cents*	*Dollars*
1924	8,000	4,374	274	47	128.78
1925	40,000	20,586	257	41	105.37
1926	28,000	16,382	277	31	85.87
1927	44,000	24,350	275	38	104.50
1928	50,000	28,310	284	38.3	108.77
1929	62,400	27,900	211	33	69.63
1930	43,639	22,000	252	19	47.88
UPLAND					
1924	122,000	61,000	250	23	57.50
1925	65,000	47,341	364	22	80.08
1926	75,000	47,344	315	14	44.10
1927	39,185	25,000	319	20	63.80
1928	88,000	59,390	357	20	71.40
1929	82,700	60,654	356	17	60.52
1930	74,665	50,000	335	9.8	32.83

[1] The data for the years 1924 to 1928, inclusive, were derived from (*17*). Data for 1929–30 were obtained from M. R. Wells, of the Bureau of Agricultural Economics, U. S. Department of Agriculture, and other sources.

Aside from the difficulties in marketing the cotton crop, several important production problems have confronted the cotton growers in the Salt River Valley during the last six years. The maintenance of adequate supplies of pure planting seed of the Pima variety, which for many years was carried on by the Tempe Cotton Exchange in cooperation with the United States Department of Agriculture, was taken over about 1924 by an organization known as the Maricopa County Farm Bureau Pure Seed Association. This organization consists of representative cotton growers, buyers, and ginners, assisted by officials of the Agricultural Extension Service of the University of Arizona and the United States Department of Agriculture. The arrangements by which pure stocks of Pima seed are handled and distributed have been very satisfactory, and it is estimated that 90 per cent of the acreage planted to Pima in 1930 was from the seed stocks certified by this association. During the last three years the association has also assisted the growers in producing adequate supplies of pure planting seed of the Acala variety. In the years 1928 to 1930, from 1,000 to 2,000 acres of Acala were grown under the supervision of the association, for supplying planting seed to the entire county. It was estimated by the cotton committee of the economic survey (*17, p. 18–35*) that about 75 per cent of the Acala planted in recent years was from pure seed stocks. They also estimated that about 90 per cent of the total acreage of upland cotton was planted to the Acala variety. During the last three years there has been some interest in the planting of Delfos cotton, a variety grown extensively in the Delta region of the Mississippi Valley. Several hundred acres of this variety were grown in 1930. A few growers also favored Mebane, but the acreage planted to that variety has been small.

Some of the land planted to cotton has presented difficulties in obtaining uniform and effective penetration of the irrigation water. This is especially true on the heavier types of soil that have been in cotton continuously for several years. The cotton plants grown on these impervious areas are abnormal and produce an inferior type of lint. Many growers are improving their cotton lands by turning under crops of sour clover (*Melilotus indica*) grown during the winter months, and also by rotating cotton with alfalfa, and by changing the direction of flow of the irrigation water so as to bring about a slower flow and a more effective penetration.

In 1929 the cotton leaf worm (*Alabama argillacea*) made its appearance much earlier than usual and soon infested a large part of the cotton in the valley. Some damage resulted from premature defoliation of the plants. As a result the development of some of the top bolls, especially of the Pima variety, was interrupted, and many bolls failed to mature. In 1930 the infestation did not become widespread until a later period, and the damage was not great.

In October, 1929, an infestation of the pink bollworm (*Pectinophora gossypiella*) was discovered in the eastern portion of the Salt River Valley. A thorough survey by officials of the Plant Quarantine and Control Administration of the United States Department of Agriculture and of the State entomologist's office showed that about 40,000 acres of cotton were infested or exposed to infestation. Thorough clean-up operations were conducted during the winter in the infested fields, and a noncotton zone was established in an effort to eradicate the pest.

In 1930 light infestations were found in several new locations in Maricopa County. One of these was about 25 miles west of Phoenix, and another was near Glendale. Light infestations were also discovered near the towns of Coolidge and Marana in Pinal County. In view of the small number of worms found and the widely scattered points of infestation, a policy of control in certain cotton areas was recommended by the State and Federal authorities for 1931. This involved the early clean-up of cotton fields in the fall, delayed planting in the spring, and the elimination of the practice of ratooning cotton.

COTTON-DISEASE INVESTIGATIONS

ROOT ROT

CONTROL EXPERIMENTS

A study of the use of barnyard manure in reducing injuries from cotton root rot was continued in the manner described in previous station reports (*7, 8, 9, 11*). The results of the last six years are shown in Table 3. It will be observed that the infection was greatly reduced in the manured plots after the treatment was begun. No infected plants were found in plot C2–17 in the seasons of 1927 and 1930, and none were observed in plot C2–19 in 1928 and 1929. Plot C2–19 was free from infection in 1928 notwithstanding the fact that no manure was applied prior to planting that year. It is believed that the reduced infection in the manured plots also has had the effect of reducing the infection in the control plots, which were in alternate positions with the treated plots and separated from them by a distance of only 4 feet. Many of the plants on these plots included in the manured experiment were killed by nematodes in 1926 to 1928. The damage by this organism to the crop of 1928 was so severe on plots C2–20 to C2–24 that it appeared necessary to change the cropping system in 1929. The manured plots C2–21 and C2–23 were planted to alfalfa in March of that year, and a clean fallow was maintained on the control plots C2–22 and C2–24 throughout the season. The root-rot disease became active in the two plots of alfalfa early in the summer of 1929, and by the end of the season had destroyed a large part of the crop on plot C2–24. In 1930 the entire series of plots was again planted to Pima cotton, and in that season the nematode infestation was much lighter on the four plots that had not been planted to cotton in 1929, but was more severe than ever before on plots C2–16 to C2–20, which had been in cotton continuously. On the other hand, the root-rot disease showed an increased area of infestation, especially on plots C2–21 and C2–23, on which alfalfa had been grown the year before. The presence of the alfalfa crop undoubtedly favored the extension of the fungus and enabled it to become more firmly established in these plots.

TABLE 3.—*Percentage of area infested with root rot in 1920 before treatment, and in manured and control plots at the United States field station, Sacaton, Ariz., 1925–1930* [1]

Plot No.	Treatment	1920 [2]	1925	1926	1927	1928	1929	1930
C2–16	Control	39.4	26.1	30.5	13.1	7.9	8.6	4.7
C2–17	Manured	61.9	5.3(3)	1.5(4)	0 (5)	.1(6)	.1(7)	0 (8)
C2–18	Control	77.3	24.1	24.6	13.7	2.5	.2	.6
C2–19	Manured	71.7	1.1(5)	.3(6)	.3(7)	0	0 (8)	.9(9)
C2–20	Control	47.3	18.9	21.6	16.3	10.1	8.6	10.0
C2–21	Manured	70.6	7.5(3)	7.4(4)	2.8(5)	.3(6)	[3]	5.6
C2–22	Control	65.3	18.9	14.0	1.0	.6	[4]	16.5
C2–23	Manured	63.0	6.1(3)	6.1(4)	4.4(5)	6.7(6)	[3]	42.3
C2–24	Control		62.6	48.5	15.4	6.0	[4]	23.0

[1] Figures in parentheses refer to the number of years in which manure was applied prior to planting. No manure was applied to plot C2–19 in 1928.

[2] Prior to manure treatment.

[3] Plot in alfalfa.

[4] Plot fallowed.

It seems apparent that the manuring treatment affected the yields of cotton, as is shown in Table 4. Without exception the average yield of the treated plots is greater than that of the adjacent control plots. The low yield on some of the plots was due largely to the effect of nematodes on the plants.

TABLE 4.—*Yield of Pima seed cotton on manured and unmanured plots infested with root rot at the United States field station, Sacaton, Ariz., 1925–1930*

Plot No.	Treatment	Yield of seed cotton (pounds per acre)							Average percentage of area infested
		1925	1926	1927	1928	1929	1930	Average	
C2–16	Control	766	1,057	878	787	769	834	848	15.2
C2–17	Manured 1923–30	1,043	1,239	1,522	1,318	794	852	1,128	1.2
C2–18	Control	899	1,042	902	1,011	568	398	803	10.9
C2–19	Manured 1921–30	1,327	1,308	1,415	[1] 1,387	710	797	1,157	.4
C2–20	Control	1,109	1,048	939	1,036	804	448	897	14.1
C2–21	Manured 1923–30	911	953	992	1,478	(2)	1,178	1,103	4.7
C2–22	Control	812	724	819	1,033	(3)	829	843	10.2
C2–23	Manured 1923–30	1,281	1,024	962	995	(2)	1,058	1,064	13.1
C2–24	Control	587	396	746	688	(3)	927	669	31.1

[1] No manure applied to plot C2–19 in 1928. [2] Plot in alfalfa. [3] Plot fallowed.

In 1926 and 1927 an experiment directed at the control of the root-rot disease by maintaining a clean fallow for one and two years was conducted on plots C1–1 to C1–3. The results showed that this treatment for so short a period was not effective in reducing the infested areas.

In the spring of 1927 a 1 per cent solution of carbon disulphide was applied at the rate of 3 acre-inches to a small infested area in one of the root-rot plots planted to cotton, but it failed to delay or reduce the infection. Applications of solutions of 1 per cent commercial formaldehyde and 2 per cent cresylic acid at the rate of 3 acre-inches were effective in reducing the extent of infection in plots of cotton and resulted in delaying the disease until late in the season.

In 1928 and 1929 experiments were conducted to test the effectiveness of barriers of various materials in checking the disease in alfalfa fields at the station and on the Indian school farm adjoining the station. The school farm, comprising an area of about 400 acres, is so generally infested with root rot that excellent stands of alfalfa are often destroyed within two or three years. (Fig. 6.) In one field an open trench 20 inches deep did not stop the spread of the disease, although its progress was checked for a time.

Two barriers of sheet iron extending 26 inches below the surface of the soil and encircling a small spot of infected alfalfa checked the spread of the disease from the middle of August until the end of the season. Barrier trenches 6 inches wide and 3 feet deep, filled with a mixture of 1 part fuel oil to 10 parts soil, prepared a few feet in advance of the infection in alfalfa fields, were effective in checking the spread of the disease for a period of several months in a number of tests. In some cases, however, there was evidence that the infection passed through or under the barrier after being held in check for a long period.

VIABILITY OF ROOT-ROT SCLEROTIA

An important development in root-rot investigations at the Sacaton station was the discovery in September, 1928, of a true sclerotium stage of the fungus that causes the disease (*Phymatotrichum omnivorum*). The sclerotia are small rounded or oval structures developed in the soil from swellings or enlargements of the rhizomorphic strands. They were first observed in cultures in which the organism was grown on dead cotton roots on moist sand. Later, D. C. Neal reported having found them under natural conditions in the soil at Greenville and San Antonio, Tex. (*14*); and soon afterwards J. J. Taubenhaus and his assistants reported finding them in several other locations in Texas (*19*). They were found at the Sacaton station for the first time under natural conditions in July, 1930, by Claude Hope.

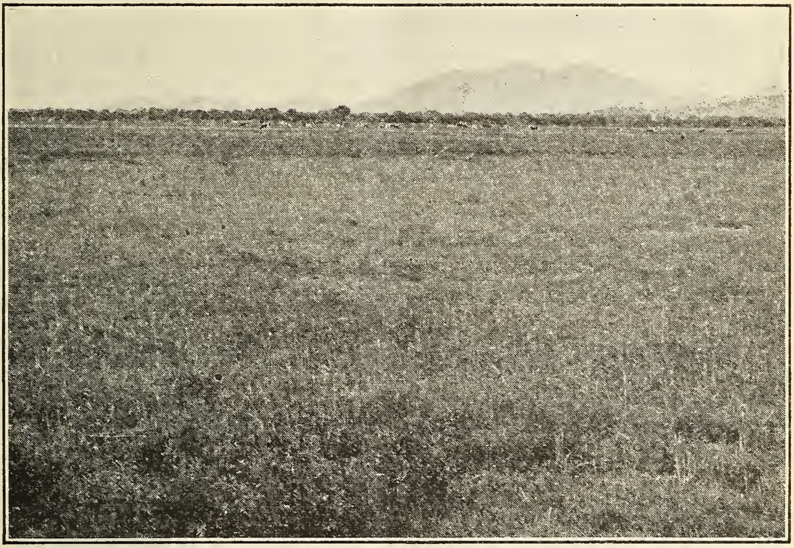

FIGURE 6.—Effect of the Phymatotrichum root-rot disease in alfalfa. The alfalfa on the area in the foreground was destroyed by the fungus in two seasons at the Indian school farm, Sacaton, Ariz. This plot is typical of large areas in alfalfa in that vicinity

When produced as single individuals, the sclerotia frequently attain a diameter of one-twelfth of an inch or more. Frequently, however, the sclerotia develop nodular masses or clusters, by a process of budding, some of which may become an inch or more in diameter. After apparently becoming dormant, some of these masses have been observed to produce new portions of growth by budding from the older parts. This process doubtless serves to prolong the life of the fungus under natural conditions.

The sclerotia are hardy structures, capable of germinating to reproduce the disease after long periods of dormancy. In cultures some sclerotia have germinated when 15 months old, and other cultures buried in the soil during the winter months continued the development of sclerotia nearly all of which were viable when tested in the spring.

Inoculation experiments with sclerotia have shown that they are capable of transmitting the disease to healthy plants under suitable conditions, and the strands from a germinating sclerotium have been observed to travel a distance of 5½ inches through an unsterile soil free from roots.

The sclerotia are easily killed by desiccation. Exposure to the air for 75 minutes has been found sufficient to destroy the viability of individuals of average size. Immersion in hot water at 115° or 116° F. for 15 minutes was found to be sufficient to kill them; while in a 1:1,000 mercuric chloride solution viability was destroyed in 4 or 5 minutes, and in a 1 per cent commercial formaldehyde solution in about 30 minutes. They were killed when exposed to formaldehyde gas from a 1½ per cent commercial formaldehyde solution in 21 hours. None of the large sclerotia or sclerotial masses were subjected to this treatment.

Nearly all of a large number of sclerotia immersed in distilled water for 92 days were viable when removed and tested, but after immersion for 121 days only 20 per cent germinated.

It was demonstrated in the laboratory that the growing mycelial strands of the root-rot fungus were able to extend a distance of 46 inches from a food supply in long glass tubes containing sand or soil. In one test the strands grew a distance of 10.5 feet during 149 days through a long tube of moist sand with small deposits of dead root tissues placed at intervals of 2.5 feet.

The strands in many cases developed sclerotia soon after the mycelium had enveloped the deposits of root tissues and advanced beyond them. These formations occurred on increments or strand growth that were several days old, between the food supply and the advance hyphae.

In a tube containing glass beads one-twelfth inch in diameter, moistened with distilled water, the root-rot strands advanced a distance of 20 inches from the inoculum placed at one end, and developed sclerotia in great numbers over a distance of 9.8 inches.

CRAZY TOP

During the last five years the crazy-top (acromania) disorder of cotton plants has become recognized as a serious problem in cotton culture in the Salt River Valley and in the Casa Grande area of the Gila River Valley. The writers have shown in a previous publication (*10*) that this disorder is closely related to unfavorable cultural conditions and that it persists in certain areas and often increases in extent until changes are made in the cultural practices.

In 1929 an experiment was conducted to determine the effects of the disorder on the fruiting activities of the plants and to ascertain whether shading some of the affected plants so as to modify the stress of high transpiration might aid them in overcoming the effects of the disorder.

The data on flowering, boll shedding, and boll retention, obtained on eight unshaded and six shaded Pima plants that were affected with the disease at the seed farm, are given in Table 5. For purposes of comparison data are also given on the activities of normal Pima plants on plots near by.

TABLE 5.—*Comparison of flowering and boll shedding of unshaded and shaded Pima cotton plants affected with the crazy-top disorder, and of normal unshaded Pima plants, at the seed farm, Sacaton, Ariz., 1929*

Treatment and affected plant number	Flowers	Bolls shed	Dead persistent bolls	Bolls retained	Bolls shed[1]
Unshaded:	*Number*	*Number*	*Number*	*Number*	*Per cent*
1	156	70	13	73	53.2
2	121	99	11	11	90.9
3	132	73	16	43	67.4
4	158	62	16	80	49.4
5	70	34	10	26	62.9
6	92	43	6	43	53.3
7	50	20	3	27	46.0
8	157	62	17	78	50.3
Average	117.0±10.37	57.9±5.83	11.5±1.25	47.6±6.53	59.2±3.66
Shaded:					
9	69	43	14	12	82.6
10	74	61	4	9	87.8
11	87	49	10	28	67.8
12	49	35	4	10	79.6
13	96	56	3	37	61.5
14	151	54	14	83	45.0
Average	87.5±10.18	49.7±2.74	8.2±1.49	29.8±8.21	70.7±4.61
Average of 10 normal unshaded plants	85.5±4.75	23.0±3.03			26.9

[1] Dead persistent bolls included.

Shading the plants failed to reduce the amount of shedding, and the percentage of normal bolls retained by the shaded plants was even less than that on those unshaded. The shaded plants also shed a high proportion of their squares and as a whole were more aberrant in character at the end of the season than the unshaded plants. It will be noted that all of the affected plants were more prolific than normal plants in the production of flowers, but a greater part of the bolls were shed at an early age. The bolls that were retained were abnormal, most of them being small and deformed, and they developed too late for normal maturity.

Although the crazy-top disorder has been quite prevalent for seven or eight years at the seed farm, it had not been observed at the field station until 1929. In that year a few plants of the Acala variety in an area where the soil was hard and impervious showed mild symptoms of the disease. (Fig. 7.)

NEMATODE INFESTATION

The widespread infestation at the station of the root-knot disease, caused by *Caconema radicicola,* has become a serious problem in recent years, especially in conducting experiments with Egyptian types of cotton. Although the evidence of infestation was apparent on many plots as early as 1920, it was not until about 1926 that the disease became serious. Prior to 1926 only a few cotton plants had been found dead as a result of the nematode infestation after reaching the fruiting stage, but during the years 1926, 1927, and 1928 Pima cotton on large areas was killed late in the season. (Fig. 8.) The upland cotton, grown on infested plots in alternate blocks with the Pima, showed only slight effects from the disease. In 1929 and 1930 the infestation was very severe during the early stages of cotton development, and on several plots excellent stands of Pima seedlings were destroyed before thinning. No mature plants were observed to be dying late in the season in 1929, and only a small number were killed in the fall of 1930. The percentage of area on which plants were actually killed on a series of plots on which Pima and Acala cotton were planted in 1927 is shown in Table 6. It will be noted that while no Acala plants were killed by the nemas in these plots, a large proportion of the Pima plants were killed.

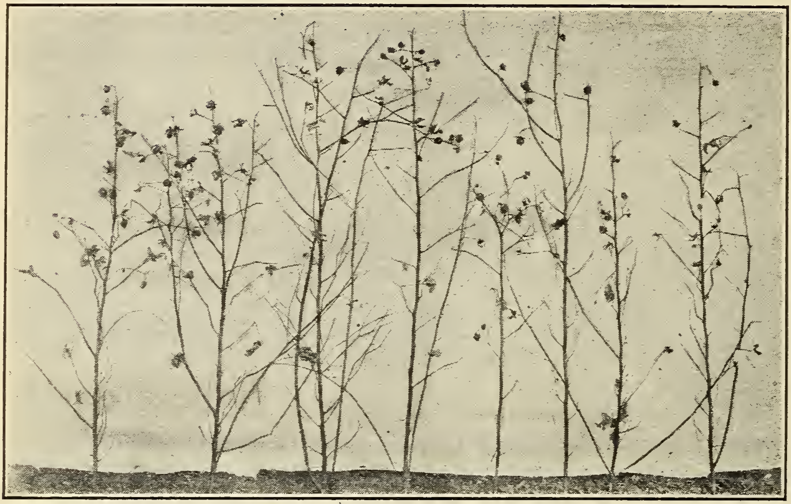

FIGURE 7.—Acala cotton plants showing mild effects of the crazy-top disorder. The sterility of the lower fruiting branches and the production of vegetative branches near the tops of the plants are two of the characteristic symptoms of the disorder

TABLE 6.—*Pima and Acala cotton plants killed by the root-knot disease (caused by Caconema radicicola) in a series of plots at the United States field station, Sacaton, Ariz., in 1927*

Plot No.	Pima		Acala		Plot No.	Pima		Acala	
	Rows	Dead plants	Rows	Dead plants		Rows	Dead plants	Rows	Dead plants
	Number	*Per cent*	*Number*	*Per cent*		*Number*	*Per cent*	*Number*	*Per cent*
C1-2	3	77	4	0	C1-10	7	17	----	----
C1-3	4	40	3	0	C1-11	7	23	----	----
C1-4	3	69	4	0	C1-12	7	22	----	----
C1-5	4	37	3	0	C1-13	7	22	----	----
C1-6	3	53	4	0	C1-14	7	15	----	----
C1-7	4	15	3	0	C1-15	7	24	----	----
C1-8	3	82	4	0	C1-16	7	26	----	----
C1-9	4	20	3	0	C1-17	7	10	----	----

Of the several methods tried for controlling the nematode disease at the Sacaton station, clean fallowing for at least two years was found to be the most effective. Several plots that had become unproductive for Pima cotton on account of the nematode disease were fallowed during 1926 and 1927 and were replanted to Pima cotton in 1928 and again in 1929.

There was no indication of injurious effects from the nemas on these plots during the entire season of 1928, but in 1929 the plants on the outside rows adjacent to badly infected plots showed symptoms of the disease.

In the winter of 1928 plots C3–9 and C3–10, comprising an area of about one-half acre that was seriously infested with Caconemas and the root-rot fungus, were covered with thermogen mulch paper, except for a small area used as a check, and were kept free of all plant growth during 1928 and 1929. One-half of another infested plot, C3–11, was maintained as a clean fallow by cultivation during the same period. In 1930 Pima cotton was planted on the fallowed portions of the three plots. During the period of fallowing, tests were made by the Division of Nematology of the Bureau of Plant Industry to determine the nematode population in samples of soil from the paper-covered area in C3–9 from unmulched soil in the same plot, and from an adjacent plot (C3–8), which was sampled in April, 1930, after crops of Pima cotton in 1928 and 1929. The results from these tests are shown in Table 7.

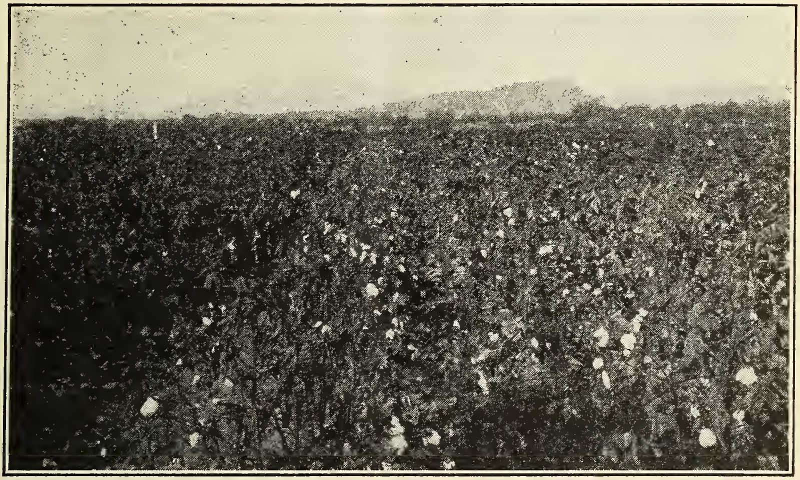

FIGURE 8.—Pima cotton plants killed by nematodes (*Caconema radicicola*) at the United States field station, Sacaton, Ariz. The upland plants in the rows at the left were little affected by the disease

TABLE 7.—*Population of Caconema radicicola and free-living nemas in an area of soil mulched with thermogen paper, and in an adjacent unmulched area cropped to cotton,*[1] *at the United States field station, Sacaton, Ariz.*

Date of sampling	Plot No.	Soil treatment	Caconema radicicola	Free-living nemas
			Number	*Number*
Nov. 21, 1928	C3–9	Unmulched	496	817
	C3–9	Paper mulched	0	164
Apr. 28, 1930	C3–8	Unmulched (plowed, no plants present)	0	306
	C3–9	Paper mulched	0	17

[1] Examinations were made by Gerald Thorne, associate nematologist, Bureau of Plant Industry.

These results indicate that fallowing is effective in reducing the number of Caconemas as well as the number of free-living nemas, and suggests that the paper-mulch method might be more effective in this respect than the unmulched fallow. However, the absence of nematode injury in the cotton crop of 1930, under both methods of fallowing, suggests the possibility that they were equally effective in controlling the Caconemas.

The paper mulch and fallow treatment had no effect in reducing the damage from the root-rot disease. In 1927 the area infested, as shown by the dead cotton plants, was 26 per cent on plot C3–9 and 23 per cent on C3–10. In 1930 the area infested was 41 per cent for plot C3–9 and 18 per cent for plot C3–10. On plot C3–11, which was maintained as a fallow by cultivation, 13 per cent of the area was infested in 1927 and only 2 per cent in 1930. However, it should not be concluded from these differences that the cultivated fallow was more effective than the paper mulch in controlling root rot, since this method failed to reduce the disease in other tests.

SORE-SHIN DISEASE

The disease of cotton seedlings known as sore shin, caused by the Rhizoctonia fungus (*Corticium vagum*), often occasions considerable damage in the irrigated cotton regions during the early spring months by reducing the stand of plants, so that replanting is sometimes necessary. In Arizona it is most severe on the heavier soils with a high moisture content, which are slow to warm up in the spring. At the field station at Sacaton, where the soil has a high water-holding capacity and where the night temperatures during the spring months are unusually low, it is not uncommon to lose from 20 to 30 per cent of the seedlings. Unfortunately, the immediate replanting of the "skips" caused by the dying of plants is not always advantageous unless there is a decided rise in the soil temperature to retard the growth of the fungus. In 1926 the spaces where the Pima cotton seedlings had been killed in a half acre at Sacaton were replanted in hills early in May. A count about three weeks later showed that the plants in more than 70 per cent of these replanted hills had died, while the mortality was very light among the older seedlings in the same rows.

An investigation made in the spring of 1929 showed that the effect of the sore-shin disease is more damaging to the stands where the plantings have been in hills than where the seeds are placed in drills. Planting in hills is often necessary in experimental plots, especially in breeding work where the quantity of seed is small. It has also been practiced to some extent in commercial plantings in Arizona, by growers who make use of seed that has been delinted by sulphuric acid. In planting the delinted seed, use is frequently made of corn plates that drop from three to six seeds to the hill at intervals of a foot or more. Owing to the habits of growth of the fungus mycelium in the soil, it usually happens that when one seedling in a cluster becomes diseased the other plants in the group are almost sure to become infected, and there is greater probability that the entire hill of plants will be destroyed than that a part of the plants will survive.

The advantage that plantings in drills have over plantings in hills, from the standpoint of sore-shin damage, is shown in Figure 9. This diagram was prepared from measurements of the spaces in which all

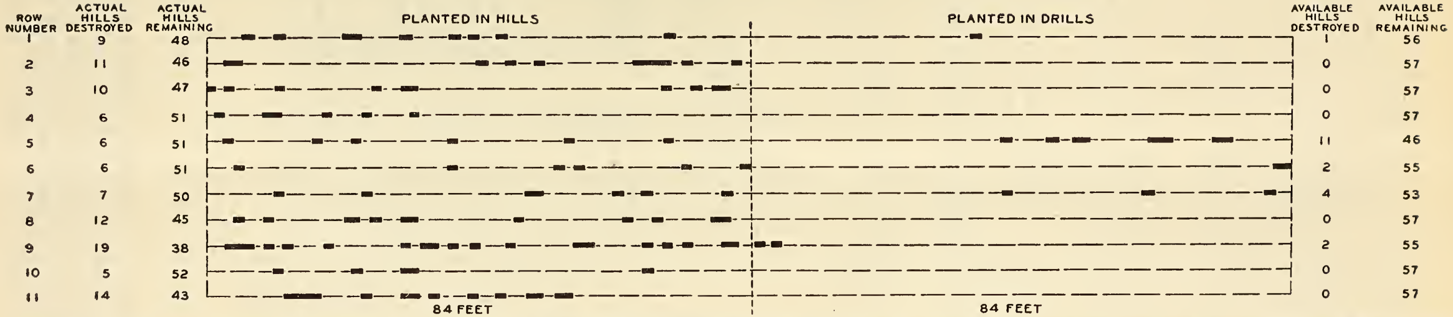

FIGURE 9.—Comparison of the number of hills of cotton seedlings destroyed by the sore-shin fungus in an area planted in hills and an adjacent area planted in drills, at the United States field station, Sacaton, Ariz.

the seedlings had been killed by sore shin in 11 row sections 84 feet long that were planted in hills and on equivalent drill-planted sections of the same length that were contiguous to the hill-planted sections. In mapping the area planted in drills the spaces less than 1.3 feet in length containing only dead seedlings were not recorded, as a spacing of cotton plants at such intervals is not regarded as a serious disadvantage. However, in the hill-planted area it is obvious that a single missing hill would be responsible for a space of 2.6 feet between plants, a spacing too great for the most effective production.

The apparent tendency for heavy losses of seedlings to occur on areas where large quantities of stable manure and straw or crops of alfalfa, clover, or grain had been recently incorporated in the soil led to an investigation to determine whether these materials contributed toward a greater activity and virulence of sore shin. Beginning in 1928, counts were made of the seedling loss on 100-foot row sections in a series of quarter-acre plots, every other one of which had received heavy applications of manure for several years. The results from these counts, two or three of which were made before the plants were thinned in 1928, 1929, and 1930, are given in Table 8.

TABLE 8.—*Percentage of Pima cotton seedlings killed by sore-shin disease in alternate plots manured and unmanured at the United States field station, Sacaton, Ariz., 1928–1930* [1]

Date planted and plot No.	Treatment	First count			Second count		Total percentage dead at last count
		Date	Total seedlings	Percentage dead	Period covered	Percentage dead	
Mar. 26, 1928:							
C2-17	Manured 1923–1928	May 5	1,042	17.65	May 5–14	15.93	33.58
C2-18	Control	do	1,044	7.95	do	2.30	10.25
C2-19	Manured 1921–1928	do	1,129	10.45	do	19.40	29.85
C2-20	Control	do	1,108	3.97	do	2.17	6.14
C2-21	Manured 1923–1928	do	738	11.11	do	11.79	22.90
C2-22	Control	do	869	4.49	do	7.48	11.97
C2-23	Manured (with green alfalfa) 1923–1928.	do	491	10.59	do	9.16	19.75
C2-24	Control	do	1,891	3.12	do	3.12	6.24
Mar. 22, 1929:							
C2-17	Manured 1923–1929	May 13	2,703	20.13	May 13–21	.30	20.43
C2-18	Control	do	1,315	8.82	do	.84	9.66
C2-19	Manured 1921–1928	do	1,790	20.73	do	2.29	23.02
C2-20	Control	do	1,148	7.14	do	.35	7.49
Apr. 18, 1930:							
C2-17	Manured 1923–1930	May 12	2,849	5.12	May 12–22	1.79	6.91
C2-18	Control	do	2,449	1.88	do	.41	2.29
C2-19	Manured 1921–1930 (except 1928).	do	2,217	13.90	do	8.85	22.75
C2-20	Control	do	2,263	2.34	do	1.02	3.36
C2-21	Manured 1923–1928, alfalfa 1929.	do	1,357	28.67	do	7.16	35.83
C2-22	Control	do	3,902	1.62	do	.59	2.21
C2-23	Manured (with green alfalfa) 1923–1928, alfalfa 1929.	do	3,386	2.54	do	.27	2.81
C2-24	Fallow 1929	do	4,557	.66	do	.11	.77

[1] The counts were made on 100-foot rows.

It will be seen that there is a marked difference in the percentage of seedlings that died on plots treated with manure and on untreated plots. The loss of stand in the manured plots in some cases was as high as 35 per cent, while the highest recorded loss on any of the control plots was about 12 per cent. Stable manure seemed to afford a more favorable medium for the activity of the fungus than the green alfalfa applied to plot C2–23.

The effect of green-manure crops on the sore-shin disease is shown by the stand count recorded in Table 9. In most cases the green-manure crop was turned under only two or three months before the cotton was planted. It will be seen that the mortality of seedlings was high for both the Pima and Acala varieties where decaying organic matter was present in large quantities. Each year the number of plants killed on the green-manure plots was more than twice as great as that on the corresponding control plots.

TABLE 9.—*Percentage of cotton seedlings killed by sore-shin disease on plots on which a green-manure crop had been recently plowed under and on adjacent or near-by plots where no cover crops were grown, at the United States field station, Sacaton, Ariz.*

Date planted and plot No.	Variety	Treatment	First count			Second count		Third count		Total percentage dead at last count
			Date	Total plants	Percentage dead	Period covered	Percentage dead	Period covered	Percentage dead	
Apr. 18, 1928:										
D1–17	Pima	Winter peas and barley.	May 11	6,882	10.7	May 11–23.	2.0			12.7
E3–7 and 8.	do	No cover crop	do	8,660	3.1	do	1.7			4.8
Apr. 5, 1930:										
D2–12	do	Alfalfa	do	1,890	3.2	do	1.2			4.4
D2–14	do	No cover crop	do	3,155	1.4	do	0			1.4
Apr. 15, 1929:										
B3–6	do	Alfalfa	Apr. 15	1,640	6.8	Apr. 15–May 7.	16.9	May 7–14.	13.8	37.5
B3–6	Acala	do	do	988	5.9	do	15.1	do	13.2	34.2
B3–7	Pima	do	do	2,379	5	do	14.4	do	16.5	35.9
B3–7	Acala	do	do	283	5	do	19.4	do	8.5	32.9
B3–8	Pima	No cover crop	do	2,158	1.4	do	6.2	do	3.5	11.1
B3–8	Acala	do	do	2,104	.8	do	4.5	do	2.8	8.1
B3–9	Pima	do	do	1,793	1.3	do	5.4	do	2.6	9.3
B3–9	Acala	do	do	1,525	.5	do	4.3	do	3.3	8.1

In making the counts of the seedling plants killed by sore shin it was noted that the proportion of dead plants often was considerably higher on the rows of Pima than on the adjacent rows of Acala. An investigation showed that the Pima rows usually had thicker stands of seedlings, and it was found that in thick plantings the percentage of dead plants was relatively greater than where fewer seedlings were present. However, it was apparent that the difference in stands was not sufficient to account for all of the difference in the rates of mortality. The data obtained from counts made on adjacent row sections of Pima and Acala for the years 1924 to 1929 are shown in Table 10.

TABLE 10.—*Relative proportions of Pima and Acala cotton seedlings killed by sore-shin disease in adjacent or neighboring row sections, at the United States field station, Sacaton, Ariz., 1924–1929*

Year	Plot No.	Total plants		Percentage killed		
		Pima	Acala	Pima	Acala	Ratio of Pima to Acala
1924	C1-13	2,662	3,137	5.68	2.23	2.54
		2,240	3,102	5.22	1.56	3.35
		3,221	2,809	12.95	1.01	12.82
1925	C1-7	1,084	608	6.46	3.29	1.96
	C1-8	723	458	4.15	5.24	.79
	C1-9	843	604	10.32	4.97	2.08
1926	C1-5	429	364	13.75	8.24	1.67
		629	320	6.68	7.50	.89
	C1-6	345	312	7.83	7.37	1.06
		577	295	7.63	5.43	1.41
	C1-7	420	408	16.20	15.44	1.05
		751	504	5.33	6.15	.87
	C1-8	286	212	10.85	17.00	.64
		413	239	10.16	2.34	4.35
1927	C2-9	2,663	578	17.20	10.55	1.63
	C2-10	2,728	1,192	30.42	10.00	3.04
	C2-11	2,299	883	22.18	4.19	5.30
	C2-12	2,654	1,038	20.89	14.85	1.40
1928	D3-17	1,574	1,706	5.97	5.45	1.10
	D3-18	1,120	2,137	9.11	6.60	1.38
	D3-19	1,863	1,339	9.34	7.24	1.29
	D3-20	1,545	1,189	8.03	6.14	1.31
	D3-21	1,336	1,923	10.68	9.31	1.15
1929	D3-13	690	187	6.7	8.6	.78
	D3-14	587	469	12.1	2.3	5.26
	D3-15	725	341	6.6	4.4	1.50
	D3-16	680	444	6.8	2.5	2.72

An examination of these data shows that in 19 of the 27 comparisons the percentage of dead Pima plants was significantly higher than the percentage of dead Acala plants. In three cases there were no significant differences, and in five cases the percentage of dead Acala plants exceeded the percentage of dead Pima plants. On this basis it would appear that Pima is more susceptible than Acala to the sore-shin disease.

COTTON CULTURAL EXPERIMENTS

VARIETY COMPARISONS

Since 1922 the cotton-growing area in the Salt River Valley has been divided between American Egyptian and upland types of cotton. Pima has been the outstanding American Egyptian variety, and Acala has been the most popular of the upland varieties and during these years has represented about 90 per cent of the upland acreage planted. The divided opinion among the growers as to which of these varieties is more profitable has made it desirable to obtain data on the yields and behavior over a number of years under comparable conditions. During recent years plantings of the two kinds have been made in alternate 3-row and 4-row blocks, and the yields from each 100-foot section of the rows have been recorded. The yields of these varieties are given in Table 11.

TABLE 11.—*Comparative yields of Pima and Acala cotton at the United States field station, Sacaton, Ariz., 1925–1930*

Year	Plot No.	Acala		Pima		Difference in favor of Acala
		Row sections 100 feet long	Average yield of seed cotton per 100-foot row	Row sections 100 feet long	Average yield of seed cotton per 100-foot row	
		Number	*Pounds*	*Number*	*Pounds*	*Pounds*
1925	C1-2 to 10	84	24.63±0.26	84	17.40±0.27	7.23±0.37
1926	do	84	21.79± .21	84	15.53± .20	6.26± .29
1927	do	84	19.89± .19	84	[1] 11.69± .19	8.20± .27
1928	D3-13 to 22	62	19.30± .39	64	15.21± .34	4.09± .52
1929	B3-5 to 10	52	26.75± .93	53	20.27± .53	6.48±1.07
1930	B3-5 to 7 and D3-1	37	17.7 ± .32	30	12.2 ± .26	5.5 ± .44

[1] The relatively low yields of Pima in 1927 were caused by a serious nematode infestation which did little injury to the Acala plants.

It will be seen that Acala outyielded Pima each year, the differences varying from about 27 per cent in 1928 to 70 per cent in 1927. The wide difference in the yields of 1927 was due in part to the greater injury of the Pima plants by a serious nematode infestation. This may have been a factor which worked to the disadvantage of Pima on the same plots in 1925 and 1926, but the effects were not then noticed, and the yields of both varieties were high. The influence of the nematode disease in 1927 is also reflected in the data on flowering and shedding. (Fig. 10.)

The opinion has been held by many growers that although Pima is well adapted to withstand stress conditions, it can be grown to better advantage where the soil is deep, fertile, and retentive of moisture and that it does not compare favorably with Acala where the two are grown on hard, impervious soil, or under conditions where little plant food and only shallow moisture are available. In order to obtain information as to this, the ratios of yields of the two types were determined from plantings of these alternate blocks on land that had been in alfalfa from one to seven years previously, and these ratios are shown in Table 12. Since it is generally believed that the effects of alfalfa are to deepen the root zone and to increase the water-holding capacity and fertility and that the effects of continuous cotton are to increase the impermeability of irrigated soils and lessen the depth of the root zone, it was believed that the yield data at various intervals after alfalfa might furnish a suggestion as to whether there was any basis for the opinion above stated.

TABLE 12.—*Ratio of Acala to Pima cotton yields from plantings one to seven years after alfalfa at the United States field station, Sacaton, Ariz., 1925–1929* [1]

Plot No.	Indicated ratio of Acala to Pima yield after number of years following alfalfa						
	1	2	3	4	5	6	7
B3-5 to 7	1.36	1.44					
B3-8 to 10						1.43	
C1-1 to 10	1.36	1.39	1.80		2.06		
C1-9		1.37	1.65	1.54			
C1-11 and 12					1.70		
C2-9 and 10				1.52		1.68	
C2-11 and 12						.86	1.16
D1-14 to 19							1.48
D3-12 to 16		1.25	1.68				
D3-16 to 21				1.31	2.13		

[1] These ratios were obtained by dividing the average yields of Acala by the average yields of Pima on 100-foot rows in a number of plots on which the two varieties were planted alternately in 3-row and 4-row blocks.

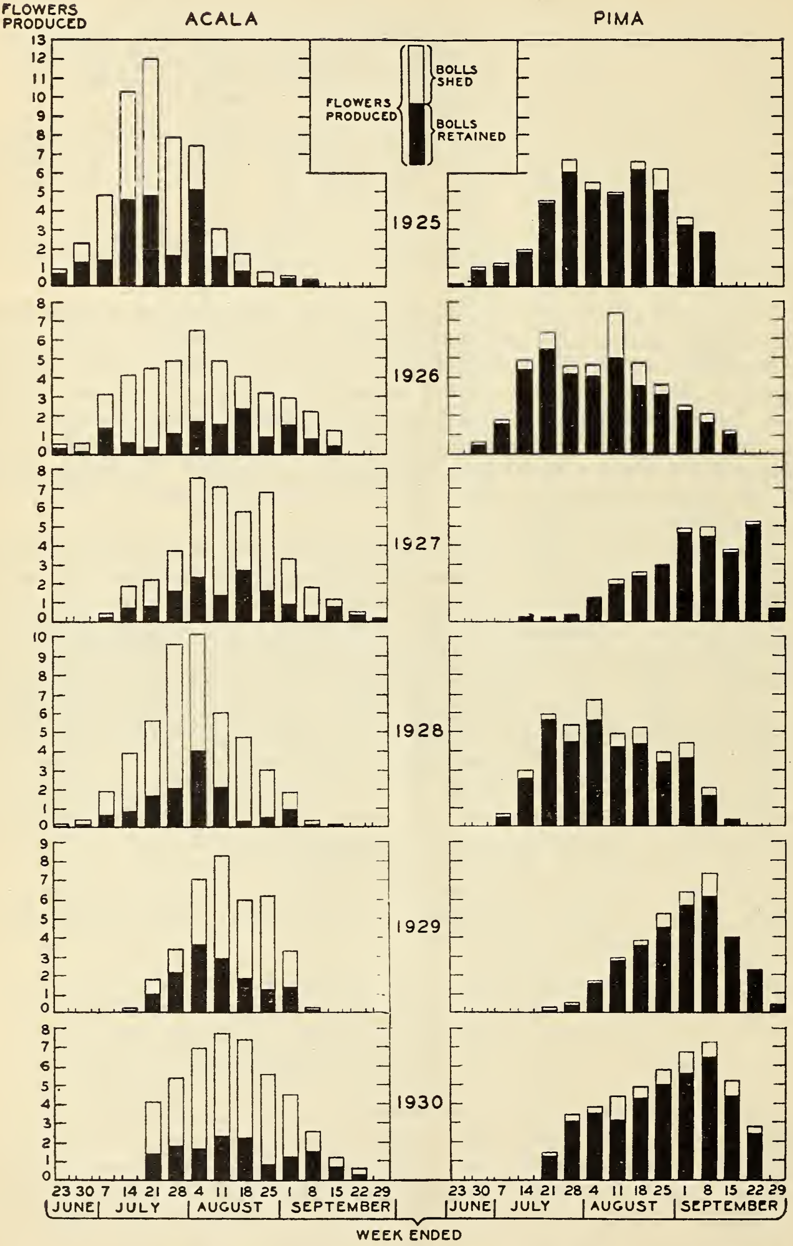

FIGURE 10.—Comparison of the rates of flowering, boll shedding, and boll retention per plant per week on Acala and Pima cotton grown under similar conditions at the United States field station, Sacaton, Ariz., 1925–1930

While the data, as shown in Table 12, are by no means consistent, it will be seen, if each group of plots is considered separately, that there is a tendency for the differences in yields to increase as the number of years after alfalfa increases. However, further data are necessary before definite conclusions are warranted.

Comparisons have also been made during the last five years between alternate plantings of the Acala, Mebane, and Lone Star varieties and in 1930 between Acala and Delfos. From 1925 to 1927 the Mebane seed, obtained from local stocks, was badly mixed, but from 1928 to 1930 seed supplies of Mebane and Lone Star were obtained from Texas, and the plants were fairly uniform; the germinating quality of the seed was poor, however, and the stands, especially in 1929, were not as good as those from the Acala seed. Also the plants were more determinate than those from the old stocks that had been grown in the Yuma and Salt River Valleys for several years, and flower counts showed that they were not as productive as the Acala plants. In 1929 a second planting was made on plots C3–17 to C3–21 to test a local stock of Mebane against Acala. The yields of the two varieties in this test were not significantly different; however, a scattered infection of root-rot complicated the results.

The yields from the plantings of the four varieties during the years 1925 to 1930 are shown in Table 13. Although Acala outyielded Mebane every year except 1926, the differences in yields were not statistically significant in 1927 and in one of the 1929 comparisons. However, in both these comparisons corrections had to be made for root-rot effects, and no statistical methods that were satisfactory could be applied.

The yields of Acala also were greater than those of Lone Star, except in 1925, when the differences were not significant. In the comparison made between Acala and Delfos in 1930 the yields of Acala were greater than those of Delfos by 5.8 pounds of seed cotton per 100 feet of row.

TABLE 13.—*Yields of seed cotton of Acala, Mebane, Lone Star, and Delfos varieties in 100-foot row sections at the United States field station, Sacaton, Ariz., 1925–1930*[1]

Year and plot No.	Variety	Row sections 100 feet long	Yield	Differences
		Number	*Pounds*	
1925:				
D1–15	Acala	14	22.3±0.85	
D1–13	Mebane	14	16.8± .73	5.5±1.12
1926:				
D1–15	Acala	7	34.8± .94	
D1–13	Mebane	7	36.9±1.24	2.1±1.56
1927:				
C3–5 to 12	Acala [2]	46	17.8± .37	
C3–5 to 12	Mebane [2]	34	16.6± .43	1.2± .57
1928:				
C1–3 to 7	Acala	42	19.5± .24	
C1–3 to 7	Mebane	42	16.7± .22	2.8± .33
1929:				
C1–8 to 10	Acala	24	18.7± .50	
C1–8 to 10	Mebane	24	9.1± .55	9.6± .74
C3–17 to 21	Acala [2]	28	21.7± .49	
C3–17 to 21	Mebane [2]	28	20.5± .41	1.2± .64
1930:				
C1–5 and 6	Acala	15	22.9± .63	
C1–5 and 6	Mebane	23	18.0± .41	4.9± .75

[1] In 1929 the stands of Mebane and Lone Star were not as satisfactory as those of Acala on account of the poor germinating quality of the seed.

[2] Corrected for root rot,

TABLE 13.—*Yields of seed cotton of Acala, Mebane, Lone Star, and Delfos varieties in 100-foot row sections at the United States field station, Sacaton, Ariz., 1925-1930*—Continued

Year and plot No.	Variety	Row sections 100 feet long	Yield	Differences
		Number	*Pounds*	
1925:				
D1-15	Acala	14	22.3±0.85	
D1-14	Lone Star	14	23 ± .82	0.7±1.18
1926:				
D1-15	Acala	7	34.8± .94	
D1-14	Lone Star	7	31.8± .62	3 ±1.13
1928:				
C1-7 to 11	Acala	56	20.3± .28	
C1-7 to 11	Lone Star	56	14.4± .28	5.9± .40
1929:				
C1-6 to 8	Acala	24	16.3± .52	
C1-6 to 8	Lone Star	24	11.2± .42	5.1± .67
1930:				
C1-7 and 8	Acala	24	21.6± .38	
C1-7 and 8	Lone Star	27	16.2± .33	5.4± .50
C1-3 and 4	Acala	24	22.4± .67	
C1-3 and 4	Delfos	30	16.6± .38	5.8± .77

STRAIN TESTS WITH ACALA COTTON

Since the introduction of Acala cotton into California about 1919 and into Arizona about 1922, considerable breeding work has been conducted in the effort to improve the variety for production under irrigation conditions. The greater part of this work has been done in the Coachella Valley of California by members of the staff of the United States Department of Agriculture. In the work of selection for uniformity of plant type and lint there are indications, especially under Arizona conditions, that a departure from the old type first introduced into the irrigated region has occurred. A stock of seed representing the older plant type was obtained from the Coachella Valley in 1924 and increased under isolation in the Queen Creek district of the Salt River Valley. This was maintained as the principal Acala stock in Arizona for several years, but in recent years it has been replaced by strains brought from the Coachella Valley.

From tests conducted at the Sacaton field station and in the Salt River Valley there is evidence that in some seasons the old stock, locally known as Queen Creek Acala, has some advantages over the new strains on account of being less determinate in its habits of growth and thus being able to produce a heavier crop late in the season.

The comparative yields of the Queen Creek strain and the Coachella Valley strains, as obtained in tests conducted at the field station during the years 1927 to 1930, are given in Table 14.

TABLE 14.—*Comparative yields of Queen Creek and Coachella Valley strains of Acala cotton at the United States field station, Sacaton, Ariz., 1927–1930*

Strain	Year	Plot Nos.	Row sections 100 feet long	Average yield of seed cotton per 100-foot row section	Difference
			Number	*Pounds*	
Queen Creek	1927	C2-9 to 15	42	20.13±0.34	
Coachella Valley	1927	do	42	15.90± .38	4.23±0.51
Queen Creek	1928	C1-11 to 19	54	19.37± .37	
Coachella Valley	1928	do	64	16.99± .27	2.38± .46
Queen Creek	1929	D1-6 to 10	21	22.63± .70	
Coachella Valley	1929	do	21	20.07± .60	2.56± .92
Queen Creek	1929	C2-1 to 3	28	18.76± .45	
Coachella Valley	1929	do	28	19.24± .61	−.48± .76
Queen Creek	1930	D1-15 to 18	41	20.20± .44	
Coachella Valley	1930	do	35	15.50± .40	4.70± .59
Queen Creek	1930	C2-2	8	17.00±1.39	
Coachella Valley	1930	do	6	14.20± .72	2.80±1.57

The yields of the Queen Creek strain were materially higher than those of the Coachella Valley strains in 1927, 1928, and 1930, but in 1929 the differences in the yields of the two strains were not significant. Although the differences in the plant type and behavior of these two strains are conspicuous under Arizona conditions, they are hardly noticeable in the California cotton-growing areas.

Another strain of Acala called the San Joaquin or S–5–4–1 strain, which resulted from selection work at the United States Cotton Field Station at Shafter, Calif., was tested in comparison with the latest Coachella (United States Date Garden) strain, and showed somewhat earlier and also more determinate characteristics. The yields of these two strains for the years 1927 to 1930, inclusive, are given in Table 15. There appears to be no significant difference in the yields of these two strains when considered on the basis of combined pickings.

TABLE 15.—*Comparative yields of Coachella (United States Date Garden) and San Joaquin (S–5–4–1) strains of Acala cotton on 100-foot row sections at the United States field station, Sacaton, Ariz., 1927–1930*

Strain	Year	Plot Nos.	Row section 100 feet long	Total average yield per row section
			Number	*Pounds*
San Joaquin	1927	C2–1 to 5	30	14. 2±0. 32
Coachella	1927	do	30	14. 9± . 44
San Joaquin	1928	C1–12 to 18	54	16. 3± . 22
Coachella	1928	do	40	16. 8± . 26
San Joaquin	1929	C2–14 and 15	8	27. 1±1. 31
Coachella	1929	do	8	24. 4±1. 83
San Joaquin	1930	C2–1 and 4, C2–14 and 15	32	16. 1± . 35
Coachella	1930	do	33	16. 5± . 40

IRRIGATION EXPERIMENTS

In a previous report (*8*) it was shown that early applications of water to young cotton plants may frequently stimulate them to early fruiting and result in increased yields at the first picking, and sometimes in increased total production. The disadvantages of early irrigation, however, were pointed out, and the practice was not advised for general conditions.

Although the plants may be stimulated to early fruiting activity, later in the season they become more subject to stress conditions and require water more frequently than plants under normal irrigation treatments. On especially fertile land, as after years of alfalfa, early irrigations are likely to result in overdevelopment of vegetative growth, and such conditions are not conducive to the setting of fruit or to earliness in production.

During the years 1925 to 1927 the effects of early irrigation were tested further to determine whether the results obtained in 1924, which were favorable to early irrigation, would prove consistent in later years. The same area was used each year for the experiment, but effort was made to change the treatment from year to year on individual plots. The cotton was planted in early April each season.

The plots under the early irrigation treatment during the period between planting and active flowering received 6 irrigations in 1925, 3 in 1926, and 4 in 1927, while those under the normal irrigation during the same period received 2 in 1925, 1 in 1926 and 1 in 1927. In all cases the plants were larger at flowering time and the flowers began to appear earlier on the early irrigated plots than on those under the normal irrigation treatment, but the yield relations varied in different seasons. The total average yields of seed cotton per 100 feet of row section for the two treatments during the years 1925 to 1927 are shown in Table 16.

Table 16.—*Mean yields of Acala and Pima cotton in 100-foot row sections in plots that received early and normal irrigation treatments*

Year	Variety	Plot Nos.	Early irrigation		Normal irrigation		Difference in favor of early irrigation
			Row sections 100 feet long	Average yield per row of seed cotton	Row sections 100 feet long	Average yield per row of seed cotton	
			Number	*Pounds*	*Number*	*Pounds*	*Pounds*
1925	Acala	C2-8 and 10	10	24.3±0.35	14	22.0±0.65	2.3±0.74
	do	C2-12 and 14	14	23.2± .36	14	20 ± .81	3.2± .87
	Pima	C2-9 and 11	14	18.2± .57	14	14.3± .52	3.9± .77
	do	C2-13 and 15	14	11.2± .62	14	12.6± .71	−1.4± .94
1926	Acala	C2-9 and 11	14	16.6± .35	14	13 ± .45	3.6± .56
	do	C2-13 and 14	8	14.6± .46	16	13.3± .50	1.3± .68
	Pima	C2-10 and 12	14	15.7± .74	14	16.6± .46	−.9± .87
	do	C2-13 and 14	6	15.5± .83	8	13.1± .51	2.4± .98
1927	Acala	C2-9 and 10	8	16.2± .46	6	16.6± .37	−.4± .59
	do	C2-11 and 12	8	16.4± .56	6	14.2± .57	2.2± .80
	do	C2-13 and 14	8	17.7± .35	5	16.7±1.28	1 ±1.33
	Pima	C2-9 and 10	6	15.4± .48	8	----------	----------
	do	C2-11 and 12	6	16 ±1.21	8	14 ± .68	2 ±1.39
	do	C2-13 and 14	6	12.6±1.08	8	13.9± .45	−1.3±1.18

In six of the seven comparisons of early and normal irrigation with Acala cotton the yields were higher under the early irrigation treatment, the differences ranging from 1.06 to 3.65 pounds of seed cotton per 100-foot row, or approximately 120 to 415 pounds per acre, over the normal irrigation treatment. (Table 16.) Of the 6 comparisons of the two treatments applied to Pima, 3 showed increased yields in favor of normal irrigation amounting to 0.95 to 1.40 pounds per 100-foot row, but the other 3 comparisons showed differences ranging between 2.04 to 3.88 pounds per row section in favor of the early irrigation treatment.

The data suggest that early irrigation applied to either of these types of cotton may be more advantageous under certain soil conditions than under the common or conventional system where irrigation water is withheld until about time for the first flowers to appear. This practice, however, is not to be recommended for general application.

In another irrigation experiment conducted in 1929 and 1930 the irrigation of certain plots on which three or four rows each of Acala and Pima were planted was so managed that after June 15 one plot received an application of water once a week, another once in two weeks, and a third once in three weeks. In 1929 only one plot was included in each treatment, but in 1930 duplicate series of plots were used. The yields obtained under each treatment are given in Table 17.

TABLE 17.—*Yields of Acala and Pima cotton from plots irrigated at different frequencies from June 15 to September 30 at the United States field station, Sacaton, Ariz., 1929 and 1930*

Year	Variety	Plot No.	Interval between irrigations	Row sections 100 feet long	Average yield of seed cotton per 100-foot row section
			Weeks	*Number*	*Pounds*
1929	Acala	D3-14	1	8	15.3±0.65
	do	D3-15	2	8	12.7± .84
	do	D3-16	3	8	11.8± .73
	Pima	D3-14	1	8	7.7± .78
	do	D3-15	2	8	6.6± .34
	do	D3-16	3	8	6.5± .58
1930	Acala	D3-2 and 5	1	14	16.5± .57
	do	D3-3 and 6	2	14	16.9± .39
	do	D3-4 and 8	3	12	14.9± .41
	Pima	D3-2 and 5	1	14	9.5± .31
	do	D3-3 and 6	2	14	10.1± .36
	do	D3-4 and 8	3	16	9.5± .29

The most significant feature of these results is small differences in yield shown as a response to these treatments. An advantage for the weekly applications is indicated, but the inconsistency of the results leaves some doubt as to whether applications of such frequency would be profitable even under the conditions that obtained in this experiment.

COTTON-SPACING EXPERIMENTS

Experiments have been conducted at the field station since 1918 to study the effects of different types of spacing on the yields and behavior of cotton plants. It has been stated in previous station reports (*7*, *8*) that most of the tests have shown evidence of advantage in leaving the plants close together. Spacings of 4, 6, 8, and 12 inches showed advantage over wider spacings, and two plants left to the hill, 1 foot apart, usually yielded slightly better than one plant per hill. The spacing tests conducted from 1925 to 1929 included comparisons of plantings left unthinned, thinned 12 inches apart with one and two plants to the hill, and spacings with the plants 4, 8, 12, and 16 inches apart in the row. The yields from these experiments are shown in Table 18.

TABLE 18.—*Average yields of Pima cotton (1925–1927) and Acala cotton (1928 and 1929) in 100-foot row sections in spacing experiments at the United States field station, Sacaton, Ariz., 1925–1929*

Treatment	Pima						Acala			
	1925		1926		1927		1928		1929	
	Row sections 100 feet long	Average yield per row	Row sections 100 feet long	Average yield per row	Row sections 100 feet long	Average yield per row	Row sections 100 feet long	Average yield per row	Row sections 100 feet long	Average yield per row
	No.	*Pounds*	*No.*	*Pounds*	*No.*	*Pounds*	*No.*	*Pounds*	*No.*	*Pounds*
Unthinned	27	12.6±0.46	22	13.8±0.49	23	13.5±0.28	----	----	----	----
Plants 12 inches apart	28	13.3± .34	19	11.7± .32	19	11.9± .27	----	----	----	----
2 plants 12 inches apart	26	17.5± .44	23	13.7± .45	23	12.9± .12	14	22.4±0.84	7	22.2±1.39
1 plant 12 inches apart	28	15.8± .31	19	12.1± .29	19	11.9± .26	14	24.8± .78	8	21.8± .99
Plants 4 inches apart	----	----	24	12.3± .29	24	12.9± .18	7	19.3±1.60	7	22.9±1.64
Plants 8 inches apart	----	----	24	12.9± .23	24	13.6± .22	7	23.9±1.93	----	----
Plants 12 inches apart	----	----	18	10.4± .30	18	12.6± .27	7	24.8±1.87	7	22.8±1.15
Plants 16 inches apart	----	----	18	11.8± .23	18	12.7± .26	7	22.3±1.59	----	----

As far as shown during the years 1925, 1926, and 1927, by yields obtained from rows left unthinned, as compared with yields from rows in which the plants were thinned 12 inches apart, thinning seems to be of no advantage. No significant differences in yields are shown between plantings of two plants per hill and one plant per hill. The yields from plantings where the spacings were 4, 8, 12, and 16 inches were not materially different during any of the four years in which the comparisons were made. While the advantages of close plantings are not so apparent in this locality as in some other parts of the cotton-growing region, it appears that spacing the plants closer than they commonly are placed would prove advantageous from a cultural standpoint and would facilitate the picking of the crop by producing smaller plants less subject to lodging and to injury by storms.

ROTATION EXPERIMENTS

During the last 6 years of the biennial rotation experiment which has been in progress for 12 years and of the continuous cotton experiment conducted for about 21 years little change has been shown in the behavior of the various plots. The yields of the different crops during the years 1925 to 1930 and the average yields of seed cotton per acre for the last 12 years are given in Table 19.

TABLE 19.—*Yields of crops in biennial rotation experiment at the United States Field Station, Sacaton, Ariz., 1925–1930*

Crops grown	Plot No.	Acre yield of Pima seed cotton (pounds)							Acre yields of other crops (bushels)					
		1925	1926	1927	1928	1929	1930	Average yield 12 years	1925	1926	1927	1928	1929	1930
Cotton continuously	D2-10	961	1,985	1,211	1,634	616	810	1,172	-----	-----	-----	-----	-----	-----
Cotton continuously, manure alternate years	D2-11	1,062	1,814	1,626	1,985	959	1,283	1,486	-----	-----	-----	-----	-----	-----
Cotton, alfalfa	D2-12	-----	2,022	-----	2,148	-----	1,164	1,637	-----	-----	-----	-----	-----	-----
Do	D2-13	1,530	-----	1,720	-----	904	-----	1,543	-----	-----	-----	-----	-----	-----
Cotton, corn	D2-14	-----	2,060	-----	1,379	-----	1,146	1,413	35.4	-----	36.4	-----	34.5	-----
Do	D2-15	1,539	-----	1,600	-----	821	-----	1,439	-----	36.4	-----	29.0	-----	60.0
Do	D2-16	-----	1,935	-----	1,681	-----	906	1,248	26.6	-----	43.7	-----	43.6	-----
Do	D2-17	1,185	-----	1,714	-----	931	-----	1,388	-----	38.3	-----	12.6	-----	42.0
Do	D2-18	-----	1,790	-----	1,481	-----	615	1,150	20.3	-----	35.6	-----	35.1	-----
Do	D2-19	1,094	-----	1,528	-----	736	-----	1,292	-----	32.8	-----	19.2	-----	34.0
Cotton, milo	D2-20	-----	2,140	-----	1,621	-----	1,009	1,357	31.2	-----	35.3	-----	62.8	-----
Do	D2-21	1,005	-----	1,678	-----	723	-----	1,495	-----	27.1	-----	-----	-----	65.0
Cotton, Sudan grass	D2-22	-----	2,331	-----	1,823	-----	1,110	1,567	-----	-----	-----	-----	-----	-----
Do	D2-23	1,193	-----	1,878	-----	934	-----	1,641	-----	-----	-----	-----	-----	-----

From the beginning of the rotation experiment it was noted that the soil conditions were variable in these plots, and the yields indicate an individuality in crop production that has been maintained. Soil conditions in plots D2–20 to D2–24 were more uniform and more favorable for production, and the highest yields of cotton have been obtained from these plots. However, an increased production of cotton has been noted on plots D2–12 and D2–13, which are rotated with alfalfa biennially, and the average yields compare favorably with the best plots in the series.

SQUARE SHEDDING

In a previous publication (*12*) the junior writer referred to the fact that the shedding of buds or squares is frequently overlooked as a factor in cotton production, and showed that the average number of squares shed by groups of observation plants of the Pima variety was 37 per cent in 1924 and 47 per cent in 1925, while the average number shed by Acala observation plants during these years was 40 and 51 per cent, respectively.

In other experiments (Table 20), during the years 1924 to 1929, records of square shedding were kept on groups of Pima and Acala plants grown in alternate blocks, in order to determine to what extent different seasons affected square shedding and to ascertain whether unfavorable seasons affected one variety more adversely than the other.

TABLE 20.—*Squares shed and flowers produced per plant per week on Acala and Pima cotton at the United States field station, Sacaton, Ariz., 1924–1929*

Year	Variety	Plot Nos.	Number of plants	Squares	(1)	Number for period or week ending—													Total for season	Percentage shed for season
						June—				July—				August—						
						7	14	21	28	5	12	19	26	2	9	16	23	30		
1924	Acala	C2-9, 11, 13	15	Shed	2.5	0.1	0.9	4.5	8.5	7.6	8.5	6.0	1.8	1.1	0.9	0.5			42.9	49.0
				Flowered		2.0	5.9	12.2	11.5	6.0	2.9	1.3	1.5	.8	.6				44.7	
	Pima	C2-10, 12, 14	15	Shed	.2		.5	3.5	6.3	3.7	7.2	8.3	4.9	4.6	3.6	1.5			44.3	48.3
				Flowered		.2	4.8	10.5	9.8	8.3	6.0	4.1	2.0	1.4	.3				47.4	
1925	Acala	C2-8, 10	9	Shed	10.7	8.3	8.9	11.7	11.6	5.9	5.7	5.7	1.4	.9					70.8	76.4
				Flowered	5.4	2.2	6.1	2.1	1.6	1.9	.7	.8	.3	.7	.1				21.9	
	Pima	C2-9, 11	10	Shed	3.2	3.3	4.4	2.9	4.6	4.6	3.3	7.5	4.8	2.6	.8				42.0	52.0
				Flowered	3.0	2.8	5.9	5.4	5.8	3.7	3.1	5.0	2.8	1.1	.1				38.7	
1926	Acala	C2-9, 11	10	Shed	10.4		3.0	6.3	9.2	8.5	6.2	4.6	1.8	.7	.3				51.0	57.8
				Flowered	5.4		8.6	7.0	6.3	5.5	3.2	1.0	.1	.1					37.2	
	Pima	C2-10, 12	10	Shed	5.5		.8	3.0	6.5	4.5	5.3	8.3	2.8	1.1					37.8	51.4
				Flowered	6.3		6.9	6.6	6.7	6.6	2.1	.5							35.7	
1927	Acala	C1-4, 5, 6, 7	20	Shed	5.9					2.0	3.4	2.5	3.4	4.3	1.4	.3	0.1		23.3	43.5
				Flowered	6.5					6.1	5.7	5.1	4.4	2.4	.1				30.3	
	Pima	C1-4, 5, 6, 7	20	Shed	3.5					2.9	2.3	3.5	2.5	4.7	1.7	.5			21.6	55.1
				Flowered	1.7					2.0	3.4	4.1	3.6	2.8					17.6	
1928	Acala	D3-15, 16, 17, 18	19	Shed	3.6			1.7	2.0	1.4	3.4	2.0	1.9	.7					16.7	34.2
				Flowered	6.4			3.3	5.3	6.3	5.1	3.5	1.7	.5					32.1	
	Pima	D3-15, 16, 17, 18	20	Shed	1.9			.7	1.4	1.4	2.7	2.5	2.0	2.1					14.7	29.6
				Flowered	5.2			2.6	4.8	5.1	5.5	6.0	3.5	2.1					34.8	
1929	Acala	D1-16, 17, 18	14	Shed	14.6					3.1	4.3	4.9	7.2	5.6	1.8	.6	.2		42.3	55.6
				Flowered	5.8					6.9	9.3	7.8	3.6	.4					33.8	
	Pima	D1-16, 17, 18	15	Shed	4.3					1.5	3.3	4.4	2.3	2.8	4.7	5.4	2.3	0.6	31.6	49.2
				Flowered	1.9					3.0	5.1	5.1	7.0	6.4	3.3	.7	.1		32.6	

[1] The figures in this column represent squares shed and flowered before observations were begun, as obtained by a plant census when daily counts were started.

A summary of the square shedding on the observation plants during these years is shown in Table 21.

The rates of square shedding for the two types of cotton are not greatly different, although it is the habit of upland varieties to shed a much greater proportion of young bolls than Pima, as shown in Figure 10.

The shedding rate of squares was very high in 1925, especially on Acala, which lost 76.4 per cent of its buds. In 1927 the square-shedding rate of the Pima plants was somewhat higher than that of the Acala plants, and it will be seen that the Pima plants developed a much smaller number of buds than normally. This can be accounted for by the fact that a large proportion of the Pima plants in the experiment that year were affected with the root-knot nematode (*Caconema radicicola*), which caused a stunting of the plants, a suppression of low-fruiting branches, and a high rate of shedding of buds and young bolls.

TABLE 21.—*Average number of squares and flowers produced per plant, and percentage of squares shed per plant on Acala and Pima cotton at the United States field station, Sacaton, Ariz., 1924–1929*

Year	Variety	Plot Nos.	Plants	Average squares per plant	Average flowers per plant	Squares shed per plant
			Number	*Number*	*Number*	*Per cent*
1924	Acala	C2-9, 11, 13	15	87. 6±3. 36	44. 7±1. 53	49. 0±1. 28
	Pima	C2-10, 12, 14	15	91. 7±8. 21	47. 4±2. 14	48. 3±1. 28
1925	Acala	C2-8, 10	9	92. 7±5. 83	21. 9±2. 47	76. 4±1. 20
	Pima	C2-9, 11	10	80. 7±3. 38	38. 7±3. 00	52. 0±1. 85
1926	Acala	do	10	88. 2±4. 92	37. 2±1. 20	57. 8±1. 80
	Pima	C2-10, 12	10	73. 5±4. 40	35. 7±1. 54	51. 4±1. 83
1927	Acala	C1-4, 5, 6, 7	20	53. 6±2. 02	30. 3±3. 91	43. 5± . 49
	Pima	do	20	39. 2±1. 47	17. 6±1. 35	55. 1±2. 10
1928	Acala	D3-15, 16, 17, 18	19	48. 8±2. 27	32. 1±1. 92	34. 2±2. 02
	Pima	do	20	49. 7±1. 47	34. 8±1. 24	29. 6± . 95
1929	Acala	D1-16, 17, 18	14	76. 1±2. 93	33. 8±1. 42	55. 6±1. 23
	Pima	do	15	64. 2±2. 33	32. 6±1. 29	49. 2±1. 04

In Table 20 is recorded the average number of squares that were shed and the number of flowers produced per plant, in weekly periods for the principal part of each season. From this table it will be seen that the excessive shedding in 1925 occurred largely during June. The plants during that month were more advanced than usual, and the month was unusually cool and windy, and showers frequently occurred. The data show that there was a low rate of shedding throughout the growing season of 1928, and this is reflected in the yields, which were higher than normal for both types of cotton.

FLOWER PRODUCTION AND BOLL SHEDDING

The records of flowering and boll shedding as derived from scattered groups of observation plants from alternate blocks of Pima and Acala cotton are shown by diagrams for weekly periods during 1925 to 1930 in Figure 10. The diagrams show that the flowering activity of the cotton plants was much earlier in 1925 and 1926 than in subsequent years. In 1925 the peak of flowering for Acala occurred about June 20 and for Pima about two weeks later. While the shedding rate was relatively high in 1926, the total number of flowers was large, and much greater numbers of bolls were retained than usual.

The figure shows there was a high shedding rate during the wet season of 1926, especially for the Acala variety. Very few bolls were set during the last three weeks in July, when there was heavy rainfall and the plants were growing rapidly. The Pima plants, however, were not affected so adversely. The flowering activity on the Pima plants in 1927 was retarded by the nematode disease. This was due to the influence which also affected the flower production shown in Table 20. The peak of flower production was reached on the Acala plants a month before that of the Pima plants.

In 1928 the plants were grown under more favorable soil conditions than in 1927; and although the summer was exceedingly dry and hot and the shedding rate at times was high, large numbers of bolls were retained and matured.

In 1929 the test plots were planted later than usual, and the plants did not begin flowering to any extent until late July. Shedding was about normal for the Acala plants, but was exceptionally low on the Pima plants.

In 1930 the flower production was about average, and only moderate shedding occurred in spite of the heavy rains that came late in the summer.

DIURNAL GROWTH OF COTTON PLANTS

Balls (*1*), from work in Egypt, reported that direct sunshine completely inhibited the growth of cotton plants and that night temperature was the prime factor in growth during the first half of the growing season. In order to determine whether these factors were effective to the same extent under Arizona conditions, an experiment was conducted in July, 1929, in which the day and night growth of a number of Pima and Acala cotton plants about 60 days old was measured over a period of 18 days.

Four plots on which the two varieties were grown in alternate 3-row and 4-row blocks were included in the experiment. Two of these had been in alfalfa the two previous years, and the other two had been in cotton continuously for several years. Ten plants of each variety were selected in adjacent rows of each of the four plots, and all the bolls were removed from five of them in each group. Each plant was measured twice daily, at sunrise and at sunset, from July 12 to 29. The data representing the average day and night growth of the normal and defruited plants on the plots recently in alfalfa and on those in cotton continuously are shown in diagrammatic form in Figures 11 and 12.

A greater portion of the growth of all the plants was made at night, although in some cases the day growth was almost equal to that made the following night. In some cases there was an actual shrinkage during the sunshine hours, which corresponds to the behavior observed by Balls (*1*).

An attempt to correlate the daily growth rate and the minimum night temperatures failed to show the close correlation obtained by Balls, and there appeared to be only a slight indication of the influences of "heat poisoning" which he found inhibiting growth on days when the maximum temperatures exceeded 95° F.

The daily maximum was above 95° F. during 15 of the 18 days on which measurements were made and on some days reached 104°, but this showed but little effect on the subsequent growth. The growth rate of the plants on the plots that had been in alfalfa was considerably higher than that on the plots continuously in cotton. The defruited plants also grew more rapidly than the normal plants.

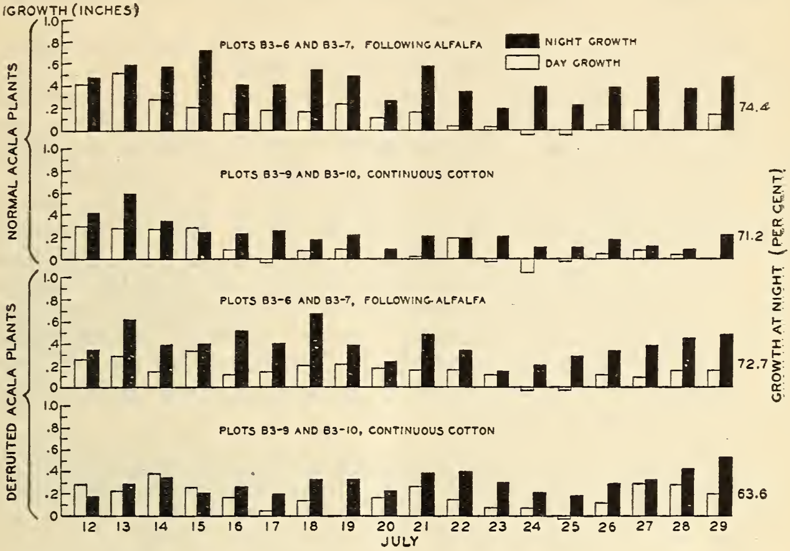

FIGURE 11.—Average day and night growth of 10 normal and 10 defruited Acala cotton plants grown on two plots following alfalfa and two plots continuously in cotton for several years

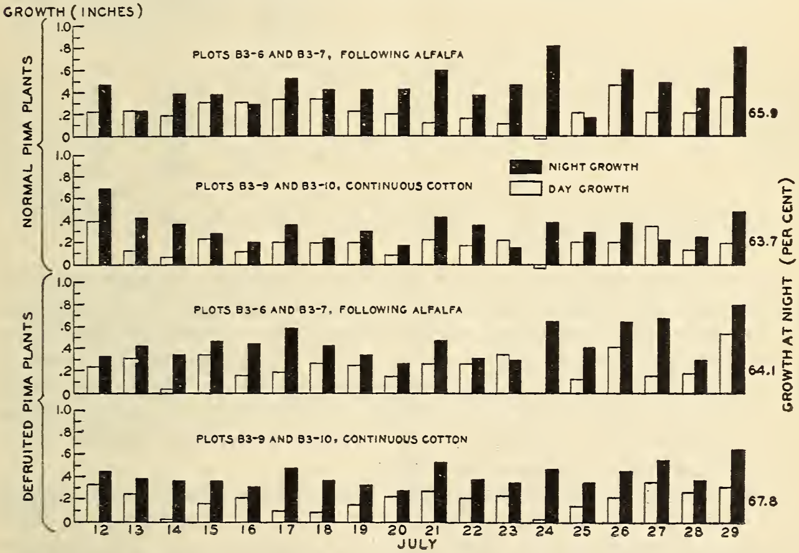

FIGURE 12.—Average day and night growth of 10 normal and 10 defruited Pima cotton plants grown on two plots following alfalfa and two plots continuously in cotton for several years

EFFECT OF ALFALFA ON SALT CONTENT OF SOIL AND ON GROWTH AND YIELD OF COTTON

Several experiments have shown that the marked effects of alfalfa in increasing the yields of cotton and other crops under the conditions at the Sacaton field station may not be due entirely to the increased fertility of the soil. There are indications that a large part of the beneficial effects may result from a reduction of the salt concentration in the soil solution so that the plants are able to utilize the soil moisture and to produce a deep and extensive root system.

A reason for the reduced productivity of land that has been in cotton continuously for many years was brought to the writers' attention by soil-moisture data obtained from a plot that had been in cotton continuously for about 18 years. Very little moisture was removed by the plants at depths below 3 feet, while on a near-by plot, rotated biennially with alfalfa, moisture was removed to a depth of 5 or 6 feet near the end of the season. Determinations of the electrical conductivity of soil samples from these plots showed that there was a high concentration of salts, which increased from the second to the fifth foot in the plot that had been continuously in cotton. On the plot that had been rotated with alfalfa the salt content was much less and decreased from the third to the sixth foot. The specific electrical conductivity, as determined for the soil from these two plots, and the equivalent in percentage of salt to dry weight of the soil are given in Table 22.

TABLE 22.—*Specific electrical conductivity* ($K\times10^5$ *at 25° C.*) *and equivalent salt contents of the soil from plots continuously in cotton for 18 years and rotated biennially with alfalfa at the United States field station, Sacaton, Ariz.*[1]

Soil horizon	Plot No. D2–10, cotton continuously 18 years, $K\times10^5$	Salt as percentage of dry soil	Plot No. D2–13, cotton, alfalfa, biennial rotation, $K\times10^5$	Salt as percentage of dry soil
First foot	185	0.140	157	0.122
Second foot	275	.215	192	.159
Third foot	428	.375	204	.145
Fourth foot	429	.377	144	.088
Fifth foot	435	.390	158	.100
Sixth foot	288	.220	148	.091

[1] These determinations were made by C. S. Scofield, George Y. Blair, and Coulsen C. Wright, of the Division of Western Irrigation Agriculture.

Further investigations showed that this condition of high salt concentration in the deeper soil horizons was common in areas that had been in cotton for a long time, and may have been a contributing factor in the reduced productivity. A series of ¼-acre plots, 400 feet in length, that had been in cotton for six years and on which the plants made unsatisfactory growth and yields, was divided into two sections in the spring of 1926, and the south half was planted to alfalfa, while the north half was continued in cotton.

In the spring of 1928 the alfalfa was plowed under, and upland cotton was planted on the entire area in that year and again in 1929. Studies were conducted to determine any differences in salt distribution in the soil or in the growth, flowering, boll shedding, and yields on the two divisions of plot C2–2 which were planted to the Acala variety. The summarized results of these studies are shown in Tables 23 and 24.

TABLE 23.—*Comparative yields of Acala seed cotton, height of plants, specific electrical conductivity of saturated soil and salt equivalent to depth of 5 feet on south half of plot C2–2, which had been in alfalfa two years, and on the north half, which had been in cotton continuously for eight years, at the United States field station, Sacaton, Ariz.*

Location of experiment, treatment, and date	Average height of plants	Average yield of seed cotton per 100-foot row section	Acre yield of seed cotton	Average specific electrical conductivity (K×10⁵)					Salt equivalent as percentage of dry soil				
				First foot	Second foot	Third foot	Fourth foot	Fifth foot	First foot	Second foot	Third foot	Fourth foot	Fifth foot
South half after 2 years alfalfa:	*Inches*	*Lbs.*	*Lbs.*										
1928	42. 8±0. 40	33. 9	4, 225	147	136	128	176	249	0. 094	0. 086	0. 080	0. 115	0. 170
1929	42. 5± . 51	25. 7	3, 194	133	156	196	305	346	. 084	. 100	. 130	. 215	. 247
North half after cotton continuously 8 years:													
1928	28. 9± . 30	13. 1	1, 634	223	280	265	330	166	. 151	. 195	. 183	. 235	. 173
1929	27. 2± . 52	15. 5	1, 936	234	347	371	480	459	. 159	. 248	. 268	. 358	. 339

TABLE 24.—*Average number of flowers per plant per week on representative Acala cotton plants on the south half of plot C2–2 which had been in alfalfa two years, and on the north half, which had been in cotton continuously for eight years, at the United States field station, Sacaton, Ariz.*

Location of experiment, treatment, and date	Average number of flowers per plant per week											Total flowers for season	Percentage bolls shed
	First week	Second week	Third week	Fourth week	Fifth week	Sixth week	Seventh week	Eighth week	Ninth week	Tenth week	Eleventh week		
South half after 2 years alfalfa:													
1928	1. 4	2. 4	6. 5	8. 7	11. 8	9. 8	10. 7	8. 0	4. 4	1. 9	1. 2	66. 8	64. 3
1929	. 9	2. 3	5. 1	8. 2	9. 5	7. 7	5. 8	5	1. 9	. 3	-----	46. 7	58. 1
North half after cotton continuously 8 years:													
1928	. 2	1. 0	3. 6	6. 6	5. 1	5. 2	4. 3	4. 9	4. 8	1. 7	. 6	38. 0	55. 2
1929	1. 7	2. 8	4. 6	4. 6	5. 6	4. 9	2. 7	1. 3	-----	-----	-----	28. 2	51. 4

The difference in plant behavior was so great that it was found necessary to vary the irrigation treatment for the two divisions. The plants on the south half grew so vigorously throughout the season of 1928 that only three irrigations were required after planting, while on the north half five applications of water were made. The mean percentage of moisture in the top 3 feet of soil of the south half in 1928 was 16.2, while in the north half it was 18.9. In 1929 the moisture percentage was 18.5 in the south half and 19.9 in the north half. However, the plants were backward in development on the north half (Table 23), and at maturity in 1928 and 1929 were smaller by 32 and 36 per cent, respectively, than those on the division that had been in alfalfa. The yields on the south division were more than double those on the north half in 1928 and almost twice as great in 1929.

PHYSIOLOGICAL STUDIES OF COTTON [2]

TEMPERATURE AND YIELDS

It was reported in a previous publication (*5*) that the yields of the Acala cotton at the Sacaton field station have been relatively low in several seasons that were characterized by high daily maximum temperatures during the fruiting period. The yields of Acala cotton were shown to average 40 per cent more in the three years 1921, 1923, and 1925, when the mean maximum summer temperatures were less than 100° F., than during 1922, 1924, and 1926, when the mean daily average was above 100°. This observation has particular interest in view of the fact that during the same period no relationship was found between summer temperatures and the yields of Pima Egyptian cotton. The greater ability of the Pima variety to withstand high temperatures finds at least a partial explanation in the fact that the temperatures of the leaves of the Pima cotton were shown to be cooler by nearly 5° than the leaves of the Acala variety. This difference in leaf temperature between Acala and Pima corresponds very closely to the difference in temperature between the seasons giving the highest and lowest Acala yields. It is pointed out in the publication above referred to that there were but six summers with maximum averages less than 100° during the 19-year period for which records were available.

EXPERIMENTS IN WHITEWASHING COTTON PLANTS

It was found that coating cotton leaves with whitewash materially reduced their temperatures. It therefore seemed desirable that tests be made to determine the effect of whitewashing upon yields. The whitewash was applied to the leaves by means of a garden hand sprayer. One coat was applied at the beginning of the flowering period, and one or two coats later in the season following heavy rains which washed off a part of the material. The results are shown in Table 25.

TABLE 25.—*Mean yields of Acala seed cotton from plots 25 feet square on which the plants were coated with whitewash during the flowering period, and on adjacent control plots of the same size that were untreated, at the United States field station, Sacaton, Ariz., 1926 and 1927*

Year, number of plots, and treatment	Average yield			
	First picking	Second picking	Third picking	Total
1926:	*Pounds*	*Pounds*	*Pounds*	*Pounds*
2, whitewashed	16.6	10.5		27.1
4, control	13.8	12.2		26.0
1927:				
7, whitewashed	15.1	7.5	2.7	25.3
8, control	13.8	8.3	2.5	24.6

With but a single exception the first picking of the whitewashed plants was higher than the mean of the two control plots on either side. The second picking yields, however, were irregular, with the average favoring the control plots. The total yields of the whitewashed plants, though higher, do not suggest that whitewashing would be practical at Sacaton, but a favorable effect is indicated. Some of the southwestern cotton sections have temperatures higher than those that prevail at Sacaton, and the suggestion is offered that under such conditions it is possible that spraying with whitewash might prove to be profitable.

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[2] Prepared by Frank M. Eaton, associate physiologist, Division of Western Irrigation Agriculture.

EFFECTS OF EARLY DEFLORATION

Investigation of the causes for the excessive shedding of bolls by upland varieties in Arizona has led to the conclusion that a very close relation exists between the rate at which organic products are made available by photosynthesis and the number of bolls that the cotton plant retains. For normal boll development it is necessary that there should be translocated to each of the bolls on a plant approximately 0.17 gram (0.02 oz.) of organic material per day. The leaf area of a plant is an important factor in the determination of the daily quantity of carbohydrates manufactured, and an early setting of bolls has been observed markedly to decrease plant growth and leaf expansion. These relationships have suggested that earliness in cotton, although generally sought by cotton breeders, under some conditions may greatly reduce yields. As a method of demonstrating this relationship experimentally, all floral buds and bolls were removed from alternate plants in a row of 200 Acala plants at Sacaton for the first three weeks of the flowering period, or until July 23. At the first picking, on October 10, 26.3 pounds of seed cotton was obtained from the 100 early deflorated plants and 19 pounds from the 100 control plants. When picked the second time on January 3 the early deflorated plants gave a yield of 4.3 pounds and the control plants 5.2 pounds, thus making a total yield of 30.6 pounds for 100 deflorated plants and 24.2 pounds for the 100 control plants.

These results find confirmation not only in the comparative behavior of very determinate strains and strains which ordinarily abort a considerable number of their early bolls but in other experiments as well. The effects of early and partial defloration upon yield and upon boll and fiber characteristics have been reported in another publication (*4*).

COTTON OF THE EGYPTIAN TYPE[3]

THE 5–3 STRAIN OF PIMA COTTON

The 5–3 strain of Pima cotton originated with a single-plant selection, representing the ninth generation of descent from a parent plant of the Pima variety. The selection was made at the Sacaton field station in 1919. Seed of strain 5–3, which was increased first on the seed farm at Sacaton and afterwards at the Litchfield ranch of the Southwest Cotton Co., was distributed for general planting in the Salt River Valley in 1929 and 1930. Several yield tests, in comparison with the old commercial stock of the Pima variety, have shown no significant difference in the yield and earliness of the two stocks; but Pima 5–3 has given consistently longer lint, the difference, in several comparisons, having ranged from one-sixteenth to one-eighth of an inch. In two spinning tests conducted by H. H. Willis, of the Bureau of Agricultural Economics, 5–3 gave somewhat stronger yarn than the original Pima stock. A selection from the 5–3 stock, designated Pima 5–11, now being grown on the seed farm, requires further testing before any conclusion may be drawn as to its merits in comparison with the original 5–3 strain.

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[3] Prepared by T. H. Kearney, principal physiologist, in charge, Division of Egyptian Cotton Breeding.

CROSSES BETWEEN PIMA AND SAKEL COTTONS

Sakellaridis cotton, commonly known as Sakel, is the longest linted of the varieties that are grown extensively in Egypt. The lint is shorter than that of Pima but is considered by some spinners to be stronger and finer. On the other hand, the Sakel variety, in comparison with Pima, has characteristics that make it unsatisfactory for growing in Arizona. The plants have more branches and are later maturing, and the bolls are smaller. A number of crosses between the two varieties have been made at the Sacaton station with the object of combining the desirable lint properties of Sakel with the desirable plant characteristics of Pima. Two of these crosses, Sakel × Pima 30 and Sakel × Pima 33, are considered promising. Both are well-marked types, differing in several respects from one another and from both of the parent varieties. The progenies of Sakel × Pima 33 and Sakel × Pima 30 grown in 1930 were of the eleventh and twelfth hybrid generations, respectively. Both crosses appear to be well "fixed" and for all practical purposes as uniform as a highly selected strain of Pima.

Sakel × Pima 30 is a rather small plant, with short fruiting branches. In yield tests in comparison with Pima this cross has shown itself to be at least equally productive and decidedly earlier in maturing. It is somewhat superior to Pima in the size of bolls and abundance of lint on the seeds. Its lint is somewhat shorter than that of ordinary Pima and averages a full one-eighth inch shorter than the lint of Pima 5–3. In color the lint closely resembles that of Sakel and is noticeably lighter than that of Pima. The seeds on an average are considerably less fuzzy than the seeds of Pima. In a comparative spinning test by H. H. Willis, of the Bureau of Agricultural Economics, Sakel × Pima 30 produced somewhat stronger yarn than either ordinary Pima or Pima 5–3, but the difference was slight.

Sakel × Pima 33 is quite a different type, the plants being large, with long fruiting branches. They make a very heavy, top crop, which is late in maturing. In favorable seasons Sakel × Pima 33 probably will outyield Pima, but when a killing frost occurs early in the fall, as was the case in 1928, there is no appreciable difference in yield. The bolls of Sakel × Pima 33 are somewhat larger and the lint is more abundant than in the case of Pima. The lint length is practically the same as that of the original Pima stock. Indications have been obtained that the plants of Sakel × Pima 33 are less liable to attack by nematodes than are plants of the Pima variety.

Additional yield tests and spinning tests of these Sakel-Pima crosses are required before a conclusion as to their agricultural and commercial possibilities would be justified.

INHERITANCE OF CHARACTERS

Inheritance of the characters that distinguish different kinds of cotton has been further investigated, in the belief that information thus obtained will be useful in practical breeding work. For example, studies made at Sacaton, as well as by cotton breeders elsewhere, have shown that absence of fuzz on the seeds, as contrasted with fuzziness, shows a simple type of inheritance, in upland as well as in Egyptian cottons. If a plant of a smooth-seeded variety is crossed with a plant of a fuzzy-seeded variety, all of the first-generation plants will be smooth seeded, and in the second generation three-fourths of the plants will be smooth seeded, and the remainder fuzzy seeded. Approximately one-third of the smooth-seeded plants will breed true. This character is of considerable practical importance, since a smooth-seeded cotton can be ginned much more rapidly than a cotton having fuzzy seeds. Determination of the manner of inheritance of smooth seededness should simplify the problem of getting a smooth-seeded strain of a variety like Pima, which normally has fuzzy seeds but is otherwise desirable.

Other characters the inheritance of which has been studied at Sacaton and found to be of a simple type are: Presence or absence of a spot on the petals in both Egyptian and upland cottons; yellow color of the pollen (as in Pima and other Egyptian cottons) contrasted with whitish color (as in most upland varieties); okra leaf as contrasted with normal leaf in upland cotton; and fruiting branches reduced to a single joint as contrasted with fruiting branches of normal length in Pima cotton. Most of these characters are of no practical importance, but, unless actually deleterious, as in the case of reduced fruiting branches, they may be useful as hall marks of otherwise desirable strains. Thus, a uniformly smooth-seeded strain of Pima having uniformly almost spotless petals has been produced with little difficulty by crossing smooth-seeded plants having the normal large red spots on the petals with fuzzy-seeded plants having almost spotless petals. Such a strain, if otherwise suitable for commercial production, could readily be kept pure, since any accidental crossing with ordinary Pima would immediately be betrayed by the reappearance of conspicuous petal spots.

A more complicated type of inheritance has been found to prevail with many characters of the cotton plant, including most of the practically important characters. Such are productiveness, size of the plant, shape and size of the bolls, and abundance, length, and color of the lint.

Experiments at Sacaton have shown that the rate of boll shedding belongs to this group of characters. Plants of Pima cotton shed a much smaller proportion of the bolls than upland cotton plants grown under the same conditions. Crosses between Pima and upland cottons produce, in the second generation, plants showing all variations in rate of shedding, from less than that of the Pima parent to greater than that of the upland parent, but there is no definite segregation into a group of light shedders and a group of heavy shedders. Yet in most cases the third-generation progenies of second-generation plants which had shed most of their bolls showed a high rate of shedding, while the progenies of plants which shed few bolls showed a low rate of shedding. This proves that rate of shedding is an inherited character. Supplemental to this investigation, the nature of the partial sterility found in many of the plants resulting from crosses between Egyptian and upland cottons is being studied cytologically by A. E. Longley, of the Division of Genetics and Biophysics, Bureau of Plant Industry.

VARIATION AND CORRELATION OF CHARACTERS

In connection with the study of inheritance of seed fuzziness in cotton, efforts were made to ascertain to what extent this character varied on the individual plant. Seeds from every boll on each of 20 Pima plants were examined, and all of the plants were found to be extremely variable. The fuzziness of the seeds depends largely upon their position on the plant, the bolls borne on the lower fruiting branches containing much fuzzier seeds than the bolls borne on the upper fruiting branches. Also, the seeds are fuzzier in bolls situated at the first nodes of the fruiting branches than in bolls situated near the ends of the branches. This accounts for the fact that in the last picking the seeds are always smoother than those from the first picking, bolls borne near the top of the plant and at the ends of the fruiting branches being the last to open.

Correlations of the boll, seed, and lint characters of Pima cotton have been studied at Sacaton. Comparison of the coefficients of correlation of the same pairs of characters in different years indicates that the closeness of the correlation varies from year to year, sometimes to the extent of changing the correlation from positive to negative, or vice versa. The causes of these seasonal variations have not been determined.

POLLINATION AND FERTILIZATION

Studies of pollination and fertilization in cotton have been continued at Sacaton, and additional data have been obtained on the subject of selective fertilization. It had been discovered, and previously reported (*6*), that when both Egyptian and upland pollen are present in equal quantity on the stigmas of either Egyptian or upland flowers, most of the ovules are fertilized by the "like" pollen, Egyptian by Egyptian, and upland by upland. Yet, when only one kind of pollen is applied, the degree of fertilization has proved to be about the same; that is to say, upland pollen, when present alone on the stigmas of Egyptian flowers, fertilizes the Egyptian ovules as readily as does Egyptian pollen; and Egyptian pollen, when present alone on the stigmas of upland cotton flowers, fertilizes the upland ovules as readily as does upland pollen. Why the unlike pollen is less effective in the presence of like pollen remains obscure, but it has been discovered that the effect depends largely upon the intimacy of the pollen mixture. If the two kinds of pollen are placed separately on opposite sides of the stigmas of an Egyptian flower, a larger proportion of the ovules will be fertilized by upland pollen than when the two kinds of pollen are mixed together before being applied to the stigmas. Evidence also has been obtained that the like pollen must be in a viable condition in order to hinder fertilization by the unlike pollen. When the like pollen is applied in a macerated state, it appears to have no inhibiting effect on the unlike pollen.

Metaxenia, or influence of pollen on tissues of the mother plant, discovered by Nixon and Swingle (*15*, *16*, *18*) in the date palm and allied species, has been found by G. J. Harrison to occur in the cotton plant also. In one experiment, flowers of Pima Egyptian cotton were fertilized with pollen of Hopi cotton, a type having much shorter lint and smoother seeds than Pima. The resulting seeds on the Pima plants, as compared with those obtained from fertilization with Pima pollen, bore significantly shorter lint and significantly less fuzz. In another experiment, Durango upland cotton, a variety intermediate between Pima and Hopi in length of the lint, was used as the female parent. Some of the Durango flowers were fertilized with Durango pollen, some with Pima pollen, and some with Hopi pollen. The lint on the resulting seeds on the Durango plants averaged a full sixteenth of an inch longer from the fertilization with Pima pollen than from the fertilization with Hopi pollen. Pima cotton requires a much longer period for maturity of the bolls than does Hopi cotton, and it was found that the Durango flowers fertilized with Pima pollen matured their bolls, on an average, one and one-half days later than the Durango flowers fertilized with Hopi pollen. This difference, also, was significant mathematically. In a third experiment it was shown that the lint from Pima cotton flowers fertilized with Acala upland pollen was shorter than that from Pima flowers fertilized with Pima pollen, and conversely, the Acala flowers produced longer lint when fertilized with Pima pollen than when fertilized with Acala pollen.

Since the lint, seed fuzz, and bolls belong to the body of the mother plant, metaxenia effects are clearly indicated by these findings. The nature of this effect is such that when two kinds of cotton differing greatly in staple length are grown in the same vicinity, as is the case in the Salt River Valley, where both Pima and Acala are grown, there is likely to be a loss of uniformity in the immediate crop proportional to the amount of cross-pollination occurring.

INFLUENCE OF INVOLUCRE LEAVES ON FRUIT

A study was made of the effect on the development of the boll by removing the 3-leaved involucre which envelops the cotton flower. It was found that when the involucre was removed on the day of flowering, the size of the boll, weight of seed cotton it contains, weight of the individual seeds, and abundance of lint (lint index) were appreciably less than in bolls from flowers not deprived of their involucres. When the involucre was removed in the bud stage, from 10 to 14 days before flowering, there was also a reduction in the average number of seeds in the boll. The results of the experiments proved, therefore, that the involucral leaves have a real function in contributing to the nourishment of the boll which they subtend.

PHYSICAL AND CHEMICAL PROPERTIES OF TISSUE FLUIDS

Investigation of the physical and chemical properties of the tissue fluids of cotton were continued at the Sacaton station until 1929 by J. Arthur Harris and his associates, but have since been discontinued owing to the death of Professor Harris.

Especial attention has been given to the differences between different types of cotton; and it was discovered that when Egyptian and upland cottons are growing in the same soil, the former show a preferential absorption of chlorides and the latter of sulphates from the soil solution. The relations between the tissue fluid properties of the plant and the concentration and chemical composition of the soil solution also have been investigated. Indications were obtained that a small quantity of alkali is favorable to the germination and early growth of Egyptian and upland cotton. Better seedling stands were secured on moderately saline soils than on soils of lower salt content.

OTHER FIELD CROPS

ALFALFA

The importance of the alfalfa crop in this region is shown by the fact that in 1930 about 110,000 acres, or 41 per cent, of the cultivated acreage in the Salt River Valley irrigation project, and 123,672 acres in Maricopa County as a whole, was in alfalfa. The average gross return per acre for alfalfa in recent years in that county has been greater than for any other general field crop except cotton (*2*).

Studies made in the Salt River Valley by Marr and Smith (*13*) during the period 1913 to 1915 show that the average amount of water used on alfalfa on 42 farms was 3.47 acre-feet, and the average yield was 5.19 tons per acre. Where 5 acre-feet of water was used the average yield was 7.2 tons.

A large proportion of the alfalfa acreage in this region is pastured to cattle or sheep part of the year, mostly during the winter months, when a large number of sheep are brought in from the northern ranges.

The alfalfa crop is of great benefit in addition to the income derived from hay and pasturage. It is one of the chief means by which the fertility of the land is built up and its productivity maintained for other crops. It has proved especially beneficial in this respect in the production of cotton and lettuce.

The varieties grown in southern Arizona are chiefly Chilean and Hairy Peruvian. In 1924 the yield in tons per acre from five varieties that had been planted at the Sacaton field station in the spring of 1923 were as follows: India 4.7, Smooth Peruvian 4.3, Hairy Peruvian 4.2, Chilean 4.4, and Turkestan 3. On account of the reduced stand in these plots due to the invasion of Bermuda grass, the alfalfa was plowed under in the fall of 1924 and was replanted on January 14, 1925, with the five varieties in the same order as before. The yields in tons per acre obtained from this planting for 1925 were as follows: India 3.5, Smooth Peruvian 3.2, Hairy Peruvian 3.3, Chilean 2.9, and Turkestan 2.3.

In this region it has been more advantageous to plant alfalfa in the fall than in the spring. Frequently a fall-planted crop will produce an average yield of hay the following year, while spring-planted crops are likely to be light the first season, and often the young plants meet more competition from weeds and grass.

BARLEY [4]

The testing of barley varieties was continued during the years 1924 to 1930. The average yields for each year are given in Table 26. Coast, Trebi, Mariout, Hero, and Peruvian were heavy producers during this period. Vaughn, which was tested in 1929 and 1930, also appears to be well adapted to this region. The light yields of some barleys in 1927 and 1928 were due largely to the poor condition of the soil.

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[4] Prepared by H. V. Harlan, principal agronomist in charge of barley investigations, Division of Cereal Crops and Diseases.

TABLE 26.—*Yields of barley varieties grown at the United States field station Sacaton, Ariz., 1924–1930*

Variety	Acre yields (bushels) [1] in —						
	1924	1925	1926	1927	1928	1929	1930
Coast	70.4	75.8(4)	63.5(2)	38.2(4)		65.1(2)	65.7(7)
Mariout	56.3		41.3(3)	39.5(4)	32.7	69.6	57.6(7)
Trebi	65.7(2)	68.5(3)	74.3(3)	42.2(4)	22.9	41.6	58.5(4)
Orel		56.4(4)	63.8(2)	25.5(4)	23.4	34.8	30.7(3)
Peruvian			68.3(2)	47.0(4)	60.5		
Hero		76.2(4)	52.1(2)	47.0(4)		71.8(2)	54.3(7)
Meloy		53.2(3)		36.1(3)			
Sandrel			68.8(2)	45.0(3)			
Wisconsin Winter		57.4(3)	37.1(2)	12.5(3)			
Vaughn						56.3(2)	66.1(6)

[1] Where the yields were computed from more than 1 plot the number of replications is shown in parentheses.

Over 2,000 barleys from foreign sources have been tested at Sacaton to determine their fitness for growing in southern Arizona. Of the large number grown, all have been eliminated but the six or seven from which a final choice is still to be made. The highest yielding sorts came mostly from northern Africa, India, and Afghanistan.

Among the few varieties left is one arising from a cross between Lion and Coast. The success of this variety lends encouragement to an extensive program of hybridization now under way. It is expected that a great many hybrids will be tested in the next 10 years.

Some rather extensive genetic work has been under way on the question of the inheritance of the time of heading. A comparison is being made of the behavior in a number of crosses when planted at Sacaton and elsewhere.

WHEAT

Wheat has long been one of the important crops of the Pima Indians, and as the fertile lands along the Gila River are well suited to wheat production, it will no doubt continue to be grown extensively. In cooperation with the Division of Cereal Crops and Diseases, the field station has continued to make tests for the comparison of the most promising wheat varieties. In Table 27 are presented the yields of the different varieties that were compared during the years 1924 to 1930. In some cases the figures given represent the yields from only one plot, while in most cases they represent the average yield from two or more plots. Baart and Sonora have yielded consistently well for many years. These two varieties and Club comprise a greater part of the wheat grown by the Indians.

TABLE 27.—*Yields of wheat varieties grown at the United States field station, Sacaton, Ariz., 1924–1930*

Variety	Acre yields (bushels) [1] in—						
	1924	1925	1926	1927	1928	1929	1930
Baart	54.7	40.8(7)	25.2(5)	50.3(2)	43.2(3)	63.7(3)	41.5(12)
Sonora	61.7	40.2(3)	32.2(4)	41.0(2)	51.2(2)	67.6(2)	52.4(2)
Pacific Bluestem	42.7	60.2(2)	37.9(4)	32.0	55.1	56.9(2)	42.1(2)
Hard Federation	34.5					47.2	48.6(2)
White Federation	41.1		13.2(3)	50.0	44.2	51.4	42.1(3)
Federation	39.2	51.6(2)	19.1(3)	45.3		44.3	
Marquis	36.8	45.4(3)	40.5(3)	36.6	44.9	41.8(2)	27.6(2)
Little Club	56.5		32.4(4)	32.7(2)		52.6(2)	42.1(3)
Prelude					36.7(2)		
Pusa						59.7(2)	57.9(2)
Onas							50.0

[1] Where the yields were computed from more than 1 plot the number of replications is shown in parentheses.

It has been observed at the station that the cereal and grain-sorghum crops exhaust the fertility of the soil rapidly, and unless the lands have a high silt content or have large quantities of silt applied in the irrigation water the yields decline rather rapidly. The soil on a large part of the station consists of alternate strata of fine sand and silt in the top 5 feet, and beneath that there usually exists a layer of coarse sand and gravel.

The wheat roots are confined to the upper 5 feet and concentrate in the silt layers. After the land has been cropped to grain or sorghum for several years the succeeding wheat crop begins to show irregularities in growth, the size and productivity of the plants being largely dependent on the thickness of the silt strata beneath the surface of the soil. An illustration of this reduced productivity as affecting Baart wheat is shown in Figure 13, A, B, and C. In this figure, A shows the growth of wheat in 1924 after two crops of corn, B shows the same plot in 1927 after double cropping three years to corn and wheat, and C shows a near-by plot of Baart wheat in 1927 on land that was in alfalfa the year previous.

SORGHUM[5]

Preliminary varietal experiments with some of the common grain sorghums and two sorgo varieties were conducted during the years 1928 to 1930. The yields from these tests are shown in Table 28. These results indicate that Dwarf Yellow milo and Dwarf hegari are better adapted for grain production than varieties of kafir or feterita. It will be noted that Fargo Straightneck outyielded all other grain sorghums in 1928 and 1929 and was one of the highest producers in 1930. This variety has large, loose, erect heads and matures somewhat later than Dwarf Yellow milo. It should have possibilities in this region where irrigation water is abundant and where the growing season is long. Late-maturing sorgos such as Honey and Gooseneck produce more forage than those of the Orange and Amber types and only these two were included in the test. The Honey variety produced a higher tonnage than Gooseneck in both seasons.

TABLE 28.—*Comparative yields of grain-sorghum and sorgo varieties grown at the United States field station, Sacaton, Ariz., 1928, 1929, and 1930*

Variety	Acre yields in—					
	1928		1929		1930	
	Plot C3-14	Plot C3-15	Plot C3-7	Plot C3-8	Plot C3-18	Plot C3-19
Standard feterita..........bushels...	73.6	52.9	42.6	29.4	60.2	62.2
Dwarf hegari..........do....	58.6	56.0	48.1	55.2	103.2	108.1
Texas Blackhull kafir..........do....	53.8	56.0	46.7	43.7	63.5	59.1
Dwarf Yellow milo..........do....	56.0	72.1	69.4	70.0	96.2	88.2
Double Dwarf milo..........do....	72.6	58.6	80.0	89.4	126.8	109.6
Fargo Straightneck milo..........do....	110.0	111.6	105.5	114.2	122.6	84.0
Honey sorgo..........tons....	35.6	23.2	36.2	32.9	22.9	29.2
Gooseneck sorgo..........do....	26.3	21.1	34.2	29.2	25.5	28.5

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[5] Prepared by J. H. Martin, senior agronomist in charge of grain sorghum and broomcorn investigations, Division of Cereal Crops and Diseases.

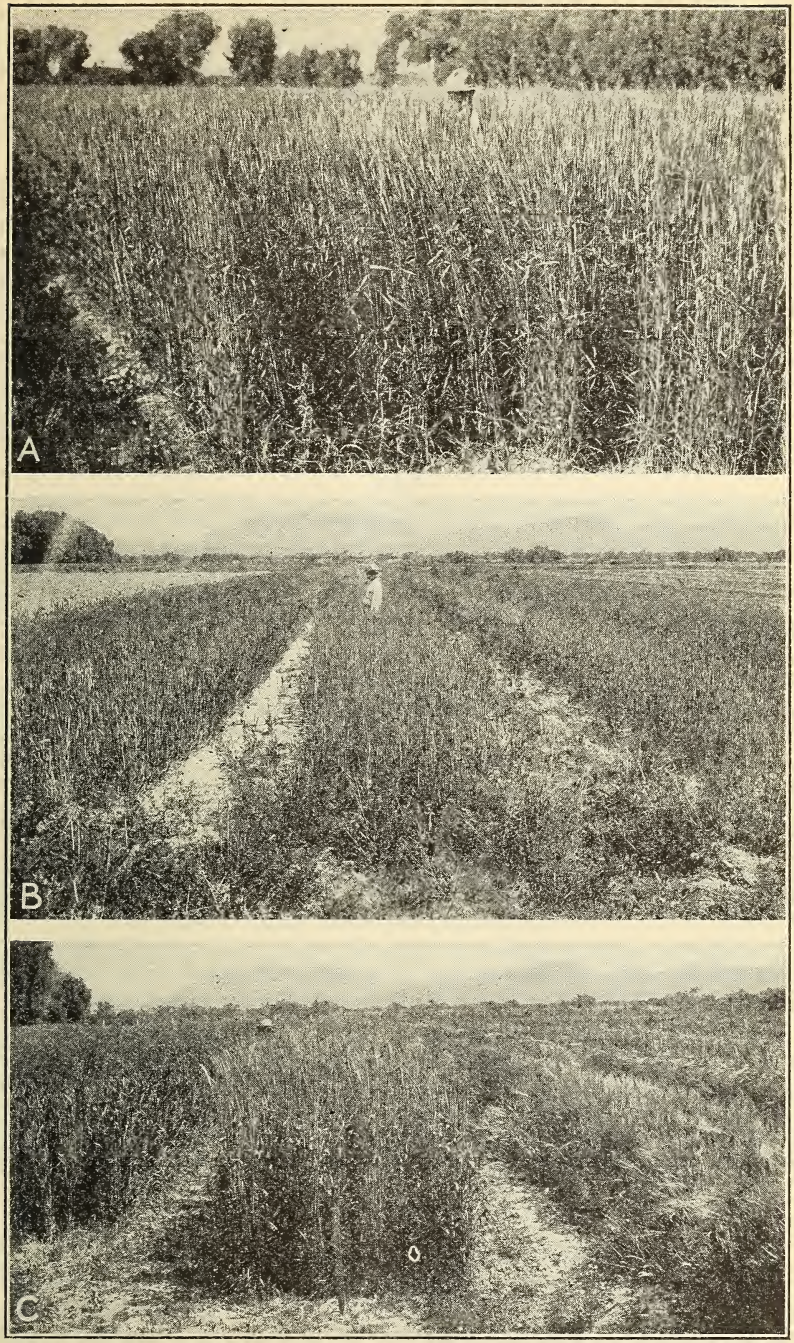

FIGURE 13.—Effect of varied crop sequences on wheat. A.—Baart wheat on plot C3-13, 1924, following two crops of corn; yield, 37 bushels per acre. B.—Same plot viewed from the opposite end. Baart wheat on plot C3-13, 1927, after double cropping three years to corn and wheat; yield, 13 bushels per acre. C.—Baart wheat on plot D3-18, 1927, following alfalfa; yield, 52 bushels per acre

About 60 varieties of sorghum recently introduced into the United States were first grown at the Sacaton field station in 1927 and 1928. None of these has shown any promise of replacing the varieties now grown. At this station grain sorghums planted in June grow taller and produce larger heads than those planted during the latter half of May.

Physiological investigations of sorghum plants have shown that a high osmotic concentration of the roots and crowns is a factor which in part may enable sorghums to withstand periods of drought better than corn. The higher osmotic concentration prevents the roots and crowns from drying out as quickly. The sorghum plants can send out tillers from the crowns even after the older stalks are killed by drought and may still produce a fair crop.

The stalk juices of certain groups of sorghum, such as feterita, durra, and milo, are characterized by a high content of salts. The sorgos have a low salt content, while kafirs have intermediate quantities of salts in their stalk juices.

CORN

VARIETY TESTS

The testing of the most promising corn varieties grown by the Indians in comparison with the Sacaton June variety was continued in 1925 and 1926. The yields per acre for those years are given in Table 29.

TABLE 29.—*Comparative yields of Sacaton June corn (Laguna) and native Indian varieties at the United States field station, Sacaton, Ariz., 1925 and 1926*

Variety	Where originated	Yield per acre (bushels)	
		1925	1926
Pima (soft)	Gila River Reservation, Ariz.	31.8	28.9
Papago (sweet)	Papago Reservation, Ariz.	25.7	23.8
San Tan (yellow)	Gila River Reservation, Ariz.	30.6	36.6
Red Pueblo	Southern Pueblo Reservation, Laguna, N. Mex.	14.7	14.8
White Pueblo	do	14.0	
Purple Pueblo	do	9.7	
Sacaton June	Gila River Reservation, Ariz.	38.8	66.4

The Sacaton June is superior to any of the Indian varieties that have been tested. It requires a longer growing season, however, and therefore requires more irrigation water for production. Now that there is an ample water supply for a greater part of the Indian lands on the Gila River Reservation, the Indians should find it more profitable to grow Sacaton June than the native varieties.

BREEDING EXPERIMENTS[6]

The Division of Genetics and Biophysics has for several years conducted experiments at Sacaton on the comparison of breeding methods for corn. The results of a comparison of a crossbreeding method and a method of isolation and recombination of selfed lines have been reported in other publications (*3, 8*). The improved strain of Sacaton June corn that resulted from these methods has been maintained by mass crossbreeding. Two methods of further improvement have been tried—(1) to find a selfed line that when used as a pollen parent on the crossbred variety will increase the yield, and (2) to find two selfed lines which when crossed will outyield the crossbred variety.

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[6] Prepared by G. N. Collins, principal botanist, in charge, Division of Genetics and Biophysics.

Although in several comparisons representatives of both methods have equaled or exceeded the parent variety, they have not been sufficiently outstanding to warrant the elaborate tests necessary to establish their superiority. In 1929 new stocks of Mexican June corn were obtained from Mississippi from which selfed lines have been isolated. It is hoped that these more distantly related lines will make a more decided contribution to the vigor of the Sacaton stock.

Since 1921 the Sacaton June variety has been subjected to an analysis by the isolation of selfed lines. About 300 selfed ears were planted in 1922, and 186 of these were continued in 1923. From that time additional selfed ears from the bulk variety have been added to the series, replacing the older lines that failed to produce seed. With the rather small planting (10 to 20 plants of each progeny) and the rigorous climate, a large percentage of the lines fail to survive more than a year or two. Of the 101 original selfed ears represented in the 1929 planting, only 3 have descended from the 300 ears selfed in 1921. Some 400 selfed lines have failed to maintain themselves under the conditions of the experiment. Since ability to reproduce itself is a necessary characteristic of any line that is to be of economic value, no special effort has been made to maintain the weak lines. An attempt was made, however, to self-pollinate plants in all progenies that produced pollen and silks.

So far as gross abnormalities are concerned, the analyses of the variety seems fairly complete. What appear to be the same types occur repeatedly, and no new characters have come to light as a result of recent selfings. Among the striking recurrent variations are "golden," "silkless," and a dominant "male sterile."

None of the selfed lines have a vigor comparable to that of the crossbred variety, and so far none has been found to make a particularly happy combination with the parent variety.

Commercial varieties of sweet corn are poorly adapted to the conditions at Sacaton, and little sweet corn is grown in southern Arizona. In 1926 crosses were made between Sacaton June corn and commercial sweet varieties with the idea of introducing the sweet character into the Sacaton variety, thus providing a sweet corn adapted to the dry, hot irrigated regions of the Southwest. Three successive back crossings to Sacaton June have resulted in plants segregating for sweet seeds that are 87.5 per cent Sacaton June. The plants are vigorous and indistinguishable in general appearance from Sacaton June. It remains to be determined whether the quality of ears is satisfactory.

ORCHARD CROPS

SEED-FARM ORCHARD

The deciduous-fruit orchard established at the seed farm in 1917 has been maintained without any extensions since the last station report in 1924. In recent years it has become badly infested with the root-knot nematode (*Caconema radicicola*), and many of the trees have been killed or severely affected. This is particularly true of the stone fruits, practically all of which have been killed. In this group the only variety that shows any degree of tolerance or nonsusceptibility to this nematode is the Chinese peach (*Amygdalus davidiana*), which may be of value as a stock but is itself of no value for fruit.

Fig trees, of which many varieties are represented in the orchard, are moderately susceptible to the root-knot nematode, which causes reduced crops on many trees and, in the more advanced stages of injury, reduces the size and quantity of the foliage and fruit. A considerable number of fig trees have been killed.

Scattered throughout the orchard are a number of olive and citrus trees, none of which has shown any effects of nematode injury. In view of this fact the replacement of trees killed by nematodes is being done with various kinds of citrus trees, and eventually the old orchard area will be devoted almost entirely to citrus experimentation and testing.

CITRUS FRUITS

The citrus industry in southern Arizona is rapidly increasing in importance. The crop in Arizona for the season of 1930–31 is estimated at 310,000 boxes of grapefruit and 110,000 boxes of oranges. Because of the interest in citrus production in this area, an orchard in which the principal varieties of citrus fruits and stocks are represented and where varieties are being tested should be of value, especially in new areas such as the recently developed San Carlos irrigation project. Several plantings of citrus have been made at the seed farm since 1919, and the behavior of many of the commercial varieties, stocks, hybrids, and some of the noncommercial citrus relatives has been very satisfactory. Except for the commercial varieties, most of the material for these plantings was furnished by W. T. Swingle, of the Division of Horticultural Crops and Diseases, who has had general supervision of the citrus testing.

Grapefruit ranks first among the citrus fruits in commercial importance in this region. The area in grapefruit in the Salt River Valley in January, 1931, was 2,200 acres of bearing trees and 5,400 acres of nonbearing trees, and in the Yuma Valley 792 acres of bearing trees and 302 acres of nonbearing trees (*2*). The Marsh is the principal variety grown in these areas. Trees of this variety have been producing satisfactory crops at the seed farm since 1925. (Fig. 14). In 1930 the yield per tree from two trees in the 1919 planting was 8 and 10 field boxes of marketable fruit. These trees have withstood temperatures below freezing each year without suffering any noticeable damage, although they have had no artificial protection in recent years.

Four varieties of oranges are represented in the orchard—Early Avery, Washington Navel, Parson Brown, and Valencia. Trees of the Valencia variety were planted in 1925 and produced their first fruit in 1929; the other varieties were planted in 1919. The Early Avery trees have fruited heavily since 1925, but the fruits vary from small to medium size and have many seeds. This variety ripens about two weeks earlier than the Washington Navel. The Washington Navel variety has borne small crops of fruit of fair to excellent quality since 1926. The Parson Brown trees produced very small crops of fruit in the years 1927 to 1929, but yielded a normal crop in 1930. The fruits in all these years were of normal size, but the juice was lacking in character and was rather insipid. The variety ripens slightly before the Early Avery, and earliness seems to be the only quality for which it can be recommended in this region.

In the spring of 1925 a Rusk citrange tree, planted in 1919, was topworked to the Clementine variety of tangerine orange. A few fruits were produced in 1927, 220 in 1928, and 371 in 1929. Most of the fruits were fully average in size for this type of orange and of fine quality. They ripen in late November and early December, somewhat before the Early Avery and Washington Navel oranges.

Two trees of the Thornton tangelo, planted in 1919, have been bearing for several years, and the variety gives promise of being a valuable addition to the citrus industry of this region. It is hybrid between the tangerine orange and the grapefruit. The fruits mature in December, are definitely pear shaped, and equal in size a very large navel orange. The juice is more like that of the grapefruit parent, but as the pith and membranes lack the bitterness of the grapefruit, the juice may be squeezed out, making a delicious drink. It also makes a valuable addition to fruit punches. When fully ripe the rather thick skin peels off readily, much as does that of the tangerine. The trees are prolific and are as hardy as grapefruit.

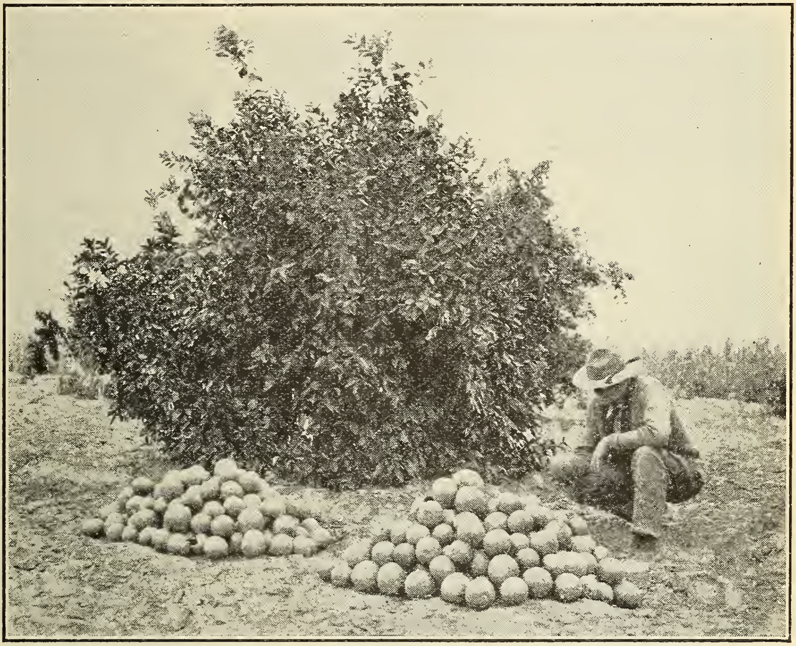

FIGURE 14.—A Marsh grapefruit tree at the seed farm, Sacaton, Ariz. The pile of fruit in the right foreground was picked from this tree, while the pile at the left was from a similar tree not shown in the illustration

Four trees of Meyer Dwarf Chinese lemon were planted in 1927, and the first fruits were produced in 1929. The variety is precocious and prolific, withstands the extremely hot summers well, and is considerably less sensitive to cold than the common varieties of lemons. The fruits are larger and more rounded than commercial lemons and are very juicy. The variety should be especially valuable for planting in home gardens throughout the warmer portions of the Southwest.

Another interesting and valuable citrus variety that is doing well at the seed farm is the Eustis limequat, a hybrid between the West Indian lime and the kumquat. While the tree has not made very rapid growth, it has fruited for several years and withstood temperatures as low as 21° F. without any protection, losing only a few of its leaves and the fruit. In the winter of 1929 it was protected with a burlap tent, and no damage occurred from a minimum temperature of 22°. Ripe fruit was available throughout the winter, and a fair crop of green fruit was carried through the winter and ripened in the spring. With moderate protection during the cold weather this variety is practically everbearing. The fruits closely resemble true limes in size, appearance, and flavor.

One tree of the Thomasville citrangequat, a citrange-kumquat hybrid planted in 1919, has produced large crops of fruit for several years. The tree is rather slender, and with the small leaves and conspicuous display of fruit is distinctly ornamental. The fruit is pear shaped and small but has an agreeable juice, and is also suitable for making marmalade.

Two trees of the calamondin (*Citrus mitis*) have attracted much attention for their ornamental value. The trees are very hardy, tall, and rather slender, with dark, glossy green foliage and a profusion of bright, orange-colored fruits an inch or less in diameter. The variety is almost everbearing, but the largest part of the crop ripens in the late fall. The acid juice is suitable for ades or fruit punches, but the small size of the fruits is a disadvantage.

DATES[7]

At the field station there are 96 date palms, comprising 24 imported varieties. Some of these have trunks 15 to 20 feet in height, and with few exceptions all are bearing fruit. In addition, the seedling orchard includes 105 palms 16 years old. All bearing palms are under observation as to their behavior in all respects but in particular as to the quality of fruit produced, with special regard for resistance of the fruit to rotting under humid atmospheric conditions. The variety planting at the seed farm is composed of 81 palms, 30 of which are in bearing. In this planting there are represented 42 Old World varieties including the Deglet Noor, which is grown extensively in the Coachella Valley of California. (Fig. 15.) It is planned to extend this planting so that ultimately there will be several individuals of every available variety, and to handle it in such a manner that at least one palm of each variety always will be bearing offshoots available for propagation. A block of 16 Hayany palms, a variety which bears offshoots in abundance, recently was set out in orchard form to furnish material for a date offshoot pruning experiment.

During 1928 and 1929, 601 offshoots were planted at Sacaton in three nurseries. Nursery No. 1 was located at the seed farm, No. 2 on plot B1–15, and No. 3 on plot C2–7 at the field station. Although date palms are very tolerant to alkaline salts, the 1928 plantings indicate that it is inadvisable to try to root date-palm offshoots in a soil that is heavily impregnated with salts. The losses were 3, 22, and 56 per cent in nurseries Nos. 1, 2, and 3, respectively, the alkali con-

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[7] Prepared by R. H. Peebles, chief scientific aide, Division of Horticultural Crops and Diseases.

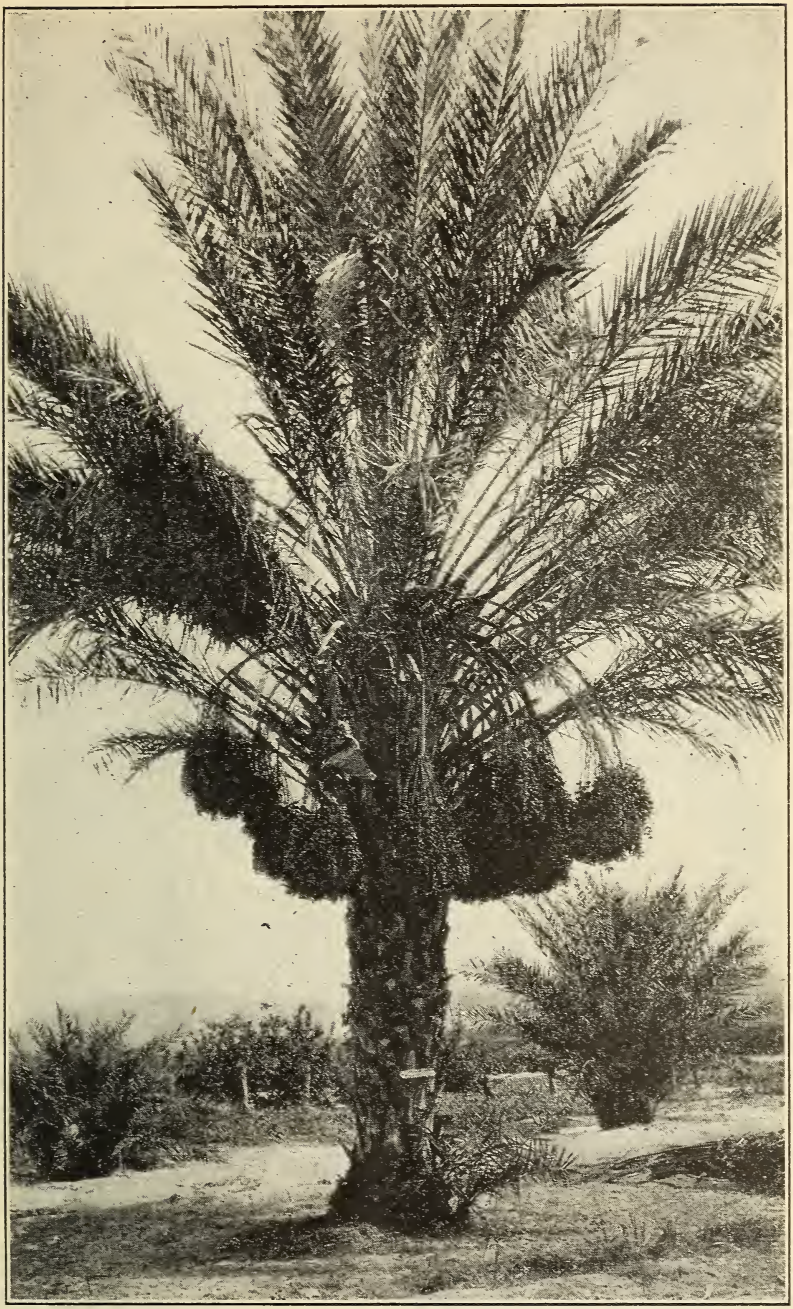

FIGURE 15.—A Deglet Noor date palm at the seed farm, Sacaton, Ariz. The weight of green fruit on this tree at the time of photographing was estimated as about 1,000 pounds. Especially heavy sets of fruit, such as this, are usually thinned to increase the size and quality of the remaining fruit and to keep the tree bearing uniformly in ensuing seasons

tent of the soil increasing greatly in the order given. In nursery No. 1 the percentage of alkali was negligible, while in No. 3 it was a serious factor in propagation. In the north end of nursery No. 3, where there was a heavy accumulation of alkali, the loss of offshoots was 72 per cent, as compared with 46 per cent at the south end, where the leaching of the irrigation water was more effective in removing the salts.

In 1930, 100 additional offshoots were planted in the nursery at the seed farm. An inspection of these offshoots in March, 1931, showed that only one had died since planting. It is believed that the high degree of success was due to the fact that the soil was of light character, well drained, and comparatively free from soluble salts, and that the irrigation frequency of two applications per week was favorable for the rooting of the offshoot.

Cooperative variety plantings are assuming an important rôle in testing promising date varieties in southern Arizona under a wide range of conditions in respect to general and local situations of the plantings and the physical and chemical composition of the soils. Three cooperative plantings were established in 1924 and are yielding valuable data on the behavior of the varieties as well as a supply of offshoots for experimentation and additional variety plantings. During 1929 and 1930 the department received 184 offshoots from the three cooperators. Part of these were utilized for new variety tests, and the remainder were placed in nursery rows or in the variety planting at the seed farm. Three additional plantings were established in 1929 and three in 1930. In 1928, 61 offshoots of 35 imported varieties were received from the Tempe date orchard, operated by the University of Arizona, and were set in nursery rows at the seed farm. Of this lot, 39 were added to the permanent variety planting at the seed farm after rooting, and most of the remainder were placed with cooperators. During the years 1928 and 1929, 93 offshoots of imported varieties were distributed to nine cooperators.

An effort was made in 1929 to interest the Pima Indians in starting the culture of dates on their farms. In cooperation with the United States Indian Service, 17 rooted Hayany offshoots were distributed in June of that year to seven Pima Indian farmers. One year later only three of the shoots had died, and these were replaced. The Hayany (fig. 16) was selected for this distribution because of the great number of offshoots that this variety produces and because of its habit of yielding heavy crops of large, attractive, reddish-black dates which ripen sufficiently on the palm to be eaten without artificial processing. As offshoots become available it is planned to furnish the Pimas with other varieties, among which will be included some of the dry dates that keep well over long periods without special treatment and are high in food value.

PECANS

The pecan industry in Arizona has experienced some severe setbacks in past years, but at present is going through another period of rapid expansion, especially in the Yuma Valley, where there are now about 1,980 acres of nonbearing trees and 44 acres of bearing trees, which produced 20,000 pounds of nuts in 1930 (*2*). Plantings are also being extended in the Salt River Valley, but not to the same extent as in the Yuma Valley. The experience of those who have been

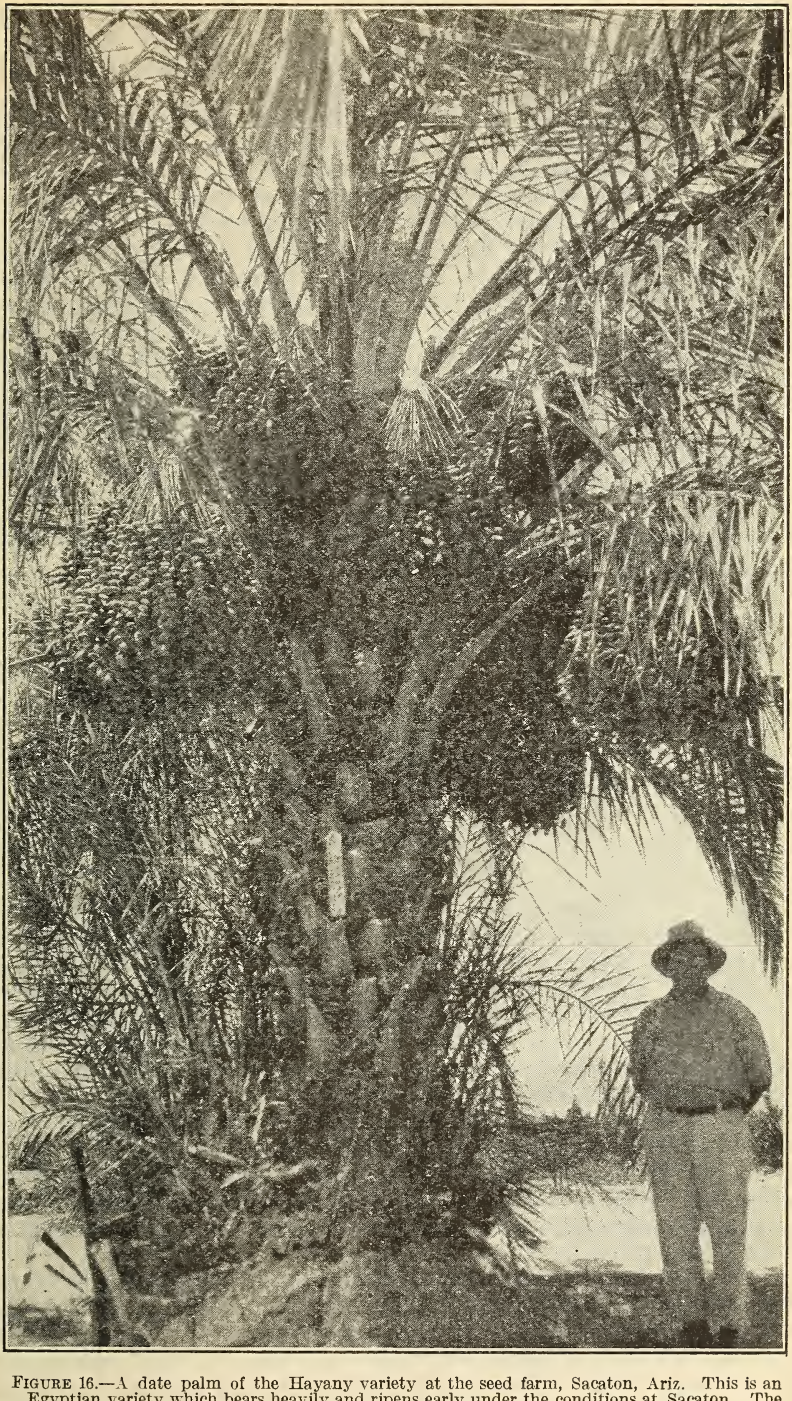

FIGURE 16.—A date palm of the Hayany variety at the seed farm, Sacaton, Ariz. This is an Egyptian variety which bears heavily and ripens early under the conditions at Sacaton. The earth was banked at the base of the palm to encourage the rooting of offshoots

handling pecan plantings in the last few years has afforded a better understanding of the requirements of pecan culture in this region, and future plantings are likely to meet with better success than have those in the past.

The pecan planting at the field station, in which about 20 varieties are represented, has shown some improvement in the growth of the trees and in production during the last few years. This doubtless resulted from the adoption of the practice of clean cultivation and the more frequent application of irrigation water. The high salt content of the soil seems to be an explanation of the poor condition of some of the trees, especially those near the north end of the station grounds. One tree each of the Kincaid and Haven varieties, located on an irrigation-ditch bank at some distance from the rest of the planting, have developed much more rapidly than the other trees; the yields were satisfactory in some years, but light in others. It is possible that this erratic behavior may be due to the fact that the pollen is partly self-sterile and that the isolated location reduces the chances of proper cross-pollination. The yields of some of the oldest trees during the years 1927 to 1930 are given in Table 30.

TABLE 30.—*Yields of dried pecan nuts from trees of different varieties at the United States field station, Sacaton, Ariz., 1927–1930*

Field	Row	Tree	Variety	Yield per tree (pounds) in—			
				1927	1928	1929	1930
C2-6	I	1	Frotscher	0	4.3	6.5	15.0
	I	5	Teche	3.8	14.5	20.5	45.7
C2-7	K	6	Delmas	3.0	6.0	12.0	10.4
	K	8	Texas Prolific (Sovereign)	40.5	10.4	10.5	11.5
	K	17	Georgia	14.1	23.5	14.5	5.9
	K	11	Kincaid	5.7	22.5	5.5	22.5
D2-6	I	1	Stuart	3.4	25.1	36.5	12.9
	K	1	Alley			34.5	26.0
On irrigation ditch			Kincaid	18.1	39.2	6.0	65.6

GRAPES

Plantings of grapes at the Sacaton field station in past years have demonstrated that the European or vinifera varieties of grapes are well adapted to this section. However, grape leaf hoppers are sometimes serious pests, and during the ripening season the grapes must be protected from June beetles. Cotton root rot (*Phymatrotrichum omnivorum*) and root knot are the only diseases of importance that affect the grape plantings in this vicinity.

More than 80 varieties of grapes have been tested at the field station in the past. Of the 49 varieties still represented in the vineyards, only 35 were bearing in 1930. Only a part of these have given satisfactory results. Although no yield records have been kept on the vines, comparative notes have been taken from time to time on the different varieties.

In the younger vineyard at the field station, planted in 1920, the most successful variety is Sultanina Rosea, a seedless table grape very similar to Sultanina *(Thompson Seedless)* in all respects except that the berries are tinged with red and that it ripens about two weeks earlier. The uniform high yields, excellent quality, and earliness of this variety are responsible for its rank. Among the other varieties of this planting, Muscat Albardiens, Black Muscat, Dattier, Malaga, and Rose of Peru rank high as fresh table grapes because of consistent high production and high quality. Monukka, an extra early seedless table grape of good flavor, has borne heavy crops, but the bunches are loose and unattractive and the berries shatter badly and do not ripen uniformly on the bunch. In 1930 the Zante currant, which has been barren in the past, was made to set a large crop of very good, extremely early fruit by girdling the canes while the vines were in full bloom. Alicante Bouschet, although only in its fourth season in 1930, gave promise of good production. Black Morocco, Black Malvoise, Cornichon, Black Ferrara, and Lady Finger are varieties that regularly bear good crops, but they cannot be recommended, as they failed to develop full flavor and quality at the station. Only one variety of American or labrusca grapes, the Concord, is growing in the station vineyards. It makes a vigorous vine growth, but the yield of fruit is usually very light.

In the original vineyard at the station the performance of the Sultanina *(Thompson Seedless)*, a seedless table grape of very good quality, gives it second place among the Sacaton varieties. Black Prince and Malaga are old varieties that are still bearing large crops of good table grapes. Only two of the old wine grapes of the original planting, Vàl de Penas and Pago di Bito, are still vigorous and productive.

The small seed-farm vineyard of 16 varieties, planted in 1920, has regularly borne good crops of excellent grapes. The best varieties there appear to be Sultana, Muscat Albardiens, Black Muscat, Dattier, and Malaga. When well fertilized the seed-farm soil seems to be more favorable for grapes than that of the station.

The best varieties of both the station and the seed-farm vineyards are being propagated for distribution to the Indians in the San Carlos project.

TRUCK CROPS

It has been demonstrated that the alluvial sandy soil at the field station is adapted to many kinds of truck crops, provided the concentration of salts is not too great. By turning under heavy applications of farmyard manure and cover crops and by growing alfalfa on the land for two or three years it has been found possible to counteract the effects of alkali to a large extent so as to make the soil more suitable for truck crops.

Head lettuce can be grown with heavy yields and high quality after such improvement of the soil and has commercial possibilities should the Indians become familiar with its culture. (Fig. 17.) About 18,400 acres were grown in Arizona as a fall crop and 16,000 acres as a spring crop for the season of 1930–31. Onions do well on the most fertile and friable soils (fig. 18), but constant vigilance is required to keep the onion thrips under control. Potatoes produce very satisfactory yields if the weather is not too hot during the spring months. The Irish Cobbler is the best suited of all the varieties tested. (Figs. 18 and 19.) In 1925 the Irish Cobbler variety yielded at the rate of 129 bushels per acre, while Bliss Triumph yielded 67 bushels and Early Ohio 78 bushels. Winter peas can be grown to advantage during the winter months and bear in profusion in most seasons.

As a fall and winter crop, carrots are admirably adapted to this section. In addition, spinach, beets, chard, radish, turnips, and mustard are successful winter crops on the station. Asparagus produces heavy crops at the station and appears well adapted for saline soils on which many other plants fail. The first cuttings are made early in March, but the heaviest cuttings come two or three weeks later. Several hundred acres of asparagus are now being grown commercially in the Eloy district of Pinal County. (Fig. 20.)

During the spring and summer months, tomatoes have been satisfactory at the field station. With good care, an early market crop could be produced on the warmer, more favorable sites in the San Carlos project. Okra has been a very dependable crop in the station garden. Sweetpotatoes have usually given good yields, although the roots are liable to be stringy if the soil has been deeply plowed.

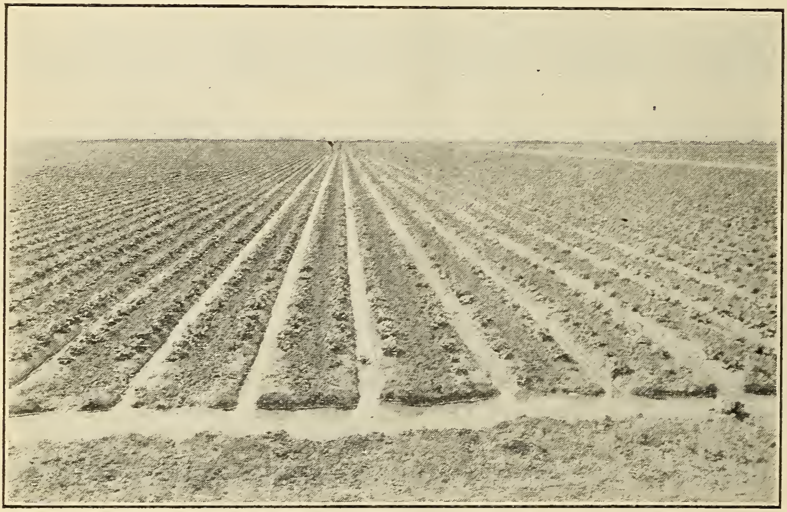

FIGURE 17.—Commercial planting of Iceberg head lettuce near Toltec, in the Casa Grande Valley, Ariz. The lettuce-shipping periods for this district are from November 15 to December 15 and from April 15 to May 15

The production of early muskmelons to supply northeastern markets has become an important industry in southern Arizona. In 1930 the Salt River Valley had 13,400 acres of early muskmelons, the bulk of which were marketed between June 20 and July 20.

Muskmelons and watermelons are grown with success under improved soil conditions at this station. Of the muskmelon varieties tried on the station, Hale's Best and Edwards Perfecto have been added to the list of desirable varieties, which included Rocky Ford and Eden Gem. The Golden Beauty (Casaba) continues to be a desirable late melon, but it should be stored for several weeks in a cool place before being used. In addition to the varieties of watermelons that have already proved well suited, such as Klondike, Kleckley Sweet, Stone Mountain, and Tom Watson, it was found in 1930 that the Irish Grey and Halbert's Honey did especially well.

The soil at the seed farm, which is a highly calcareous sandy loam, can be put into good condition for growing truck crops, such as melons, squash, cucumbers, tomatoes, beans, peas, spinach, lettuce, and asparagus, by heavy fertilization with farmyard manure and green manure and by rotation with alfalfa. Much of the land in the San Carlos project is of this type of soil and requires the addition of organic matter to bring it to satisfactory productivity.

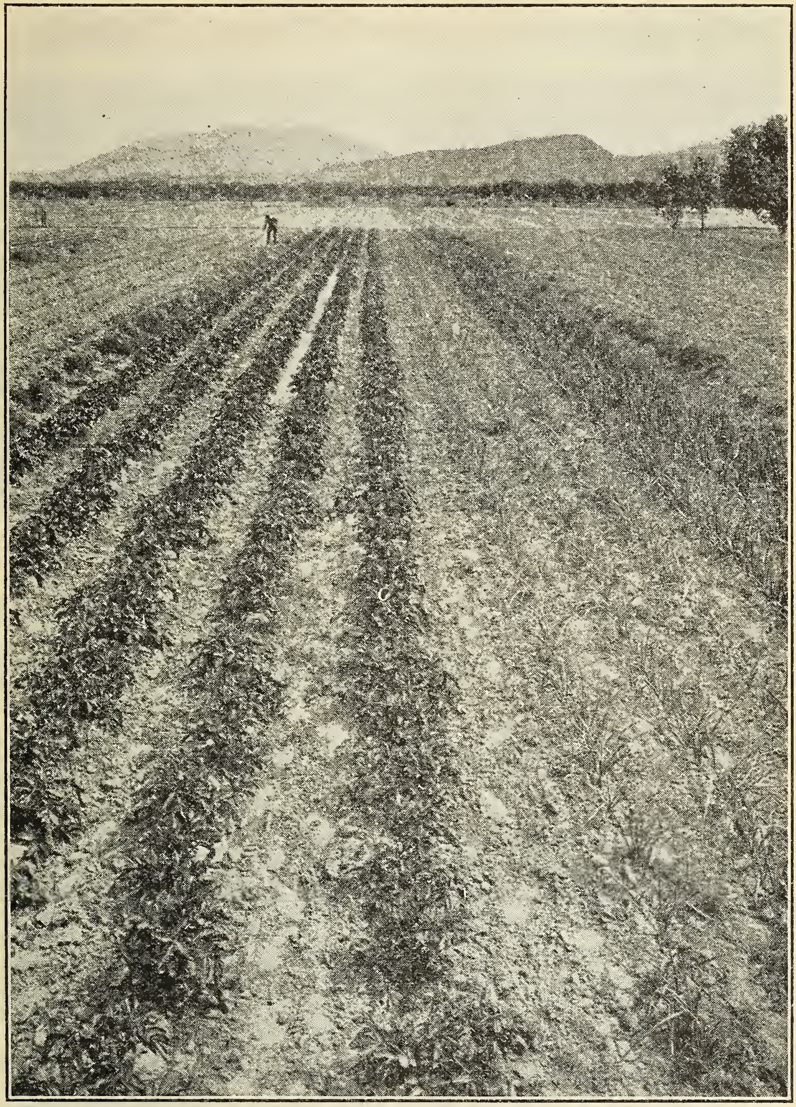

FIGURE 18.—Plots of Irish Cobbler potatoes and Yellow Bermuda and Spanish onions at the United States field station, Sacaton, Ariz.

REFERENCE HERBARIUM

During the last six years several thousand specimens of wild and cultivated plants have been collected, chiefly in the southern half of Arizona. These specimens have been mounted on standard herbarium sheets, and nearly all of them have been identified, in many cases by specialists in particular groups. Since no comprehensive publication on the flora of Arizona is available at present, this collection is indispensable as a means of identifying weeds, native plants of economic importance such as forage plants and medicinal plants, and the less well-known species under cultivation in the State. The collection is also proving useful in connection with a work on the flora of Arizona, now in preparation by the Bureau of Plant Industry in cooperation with the University of Arizona. Duplicate specimens

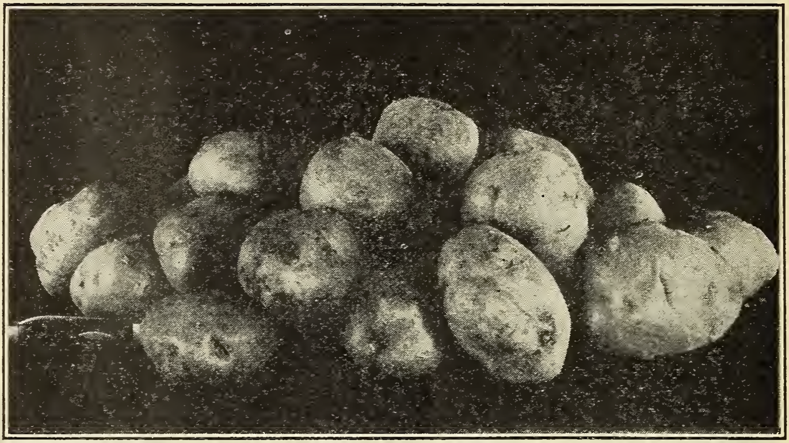

FIGURE 19.—Specimens of potatoes of the Irish Cobbler variety grown at the United States field station, Sacaton, Ariz.

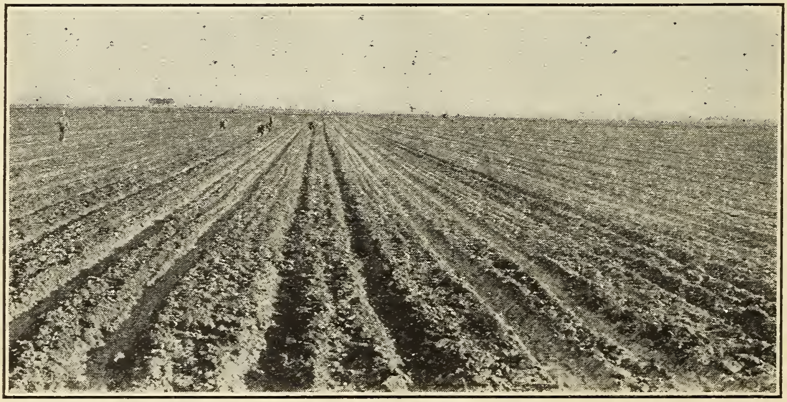

FIGURE 20.—Making early cutting of asparagus from a 360-acre planting near Eloy, in the Casa Grande Valley, Ariz., March, 1931

of most of the plants collected have been deposited in the United States National Herbarium.

In collecting material for this herbarium, several species new to science have been discovered and have been described in publications by specialists. A much larger number of species not previously known to occur in Arizona have been found to belong to the flora of the State. Some of these are Mexican plants not hitherto known to occur north of the border.

Particular attention is being given to collecting the native species of the mallow family, the group to which cotton belongs, in view of the possibility that such plants may be the hosts of insects and diseases injurious to cotton. This is known to be the case with one of them (*Thurberia thespesioides*), which harbors a weevil almost identical with the Mexican boll weevil and capable of feeding on cotton.

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U. S. GOVERNMENT PRINTING OFFICE: 1932

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